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SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1921.

Nos. 20-21, Original.

THE COMMONWEALTH OF PENNSYLVANIA, COMPLAINANT,

vs.

THE STATE OF WEST VIRGINIA.

THE STATE OF OHIO, COMPLAINANT,

vs.

THE STATE OF WEST VIRGINIA.

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a

PENNSYLVANIA

AND

OHIO

EXHIBITS

c PENNSYLVANIA EXHIBIT 1.

Offered at p. 30 of Printed Record by Witness Quay.

Map Showing Location of Main Transportation Lines of the Manufacturers Light & Heat Company in Pennsylvania, Ohio, and West Virginia.

NOTE.—This was replaced by Pennsylvania Exhibit 39 E.

d PENNSYLVANIA EXHIBIT 2.

Offered at p. 149 of Printed Record by Witness Quay.

Warning Letter Sent by the Manufacturers Light & Heat Company to Its Industrial Natural Gas Consumers, June 30, 1917.

1 The Manufacturers Light and Heat Company and Affiliated Companies.

General Offices, Columbia Bank Building.

John E. Gill, President.

Pittsburgh, Pa., June 30th, 1917.

GENTLEMEN:

You are hereby notified that there will be a change in the rates to industrial consumers of The Manufacturers Light & Heat Company, to go into effect on the first day of August, 1917, as follows:

Next 750,000 cu. ft. — ¢ per M cu. ft.
Next 2,000,000 cu. ft. — ¢ per M cu. ft.
Next 7,000,000 cu. ft. — ¢ per M cu. ft.
Next 40,000,000 cu. ft. — ¢ per M cu. ft.
All over 50,000,000 cu. ft. — ¢ per M cu. ft.

Discount of 1¢ per M. cu. ft. is allowed where payment is made on or before the twentieth of the month following that for which bill is rendered, application therefor having been filed with the Public Service Commission of your State.

While this rate has been established to be operative during the next few months when the domestic demands are comparatively light, if there is no change for the better in the cost and difficulty of obtaining a gas supply, due not only to the increased cost of production, but also to the depletion and exhaustion of developed territory and the inability so far to find new territory, then, in all probability, on or before December 1st, 1917, this Company will be

forced to withdraw its industrial rates and not undertake to supply industrial consumers.

With this probable action in prospect, you are accordingly advised to make such preparation as you may deem proper for the change of your appliances and the introduction of other fuel than natural gas.

Yours very truly,

THE MANUFACTURERS LIGHT & HEAT COMPANY,
JOHN E. GILL,
President.

1*a* PENNSYLVANIA EXHIBIT 3.

Offered at p. 149 of Printed Record by Witness Quay.

Warning Letter Sent by the Manufacturers Light & Heat Company to Its Industrial Natural Gas Consumers October 9, 1917.

2 The Manufacturers' Light and Heat Company and Affiliated Companies.

General Offices, Columbia Bank Building.

John E. Gill, President.

Pittsburgh, Pa., October 9th, 1917.

In our letter to you of June 30th, 1917, we warned you that in all probability we would be unable to supply our industrial consumers during the present winter because of our inability to produce or to buy sufficient gas for that purpose, and that you should accordingly be prepared to arrange for other fuel.

Notwithstanding every effort that we have made, both to enlarge our production and to purchase gas, we have been unable to secure an adequate supply to enable us to continue with our industrial consumers. One contract, which was made several years ago, and from which we obtain 15,000,000 feet of gas per day, will terminate on December 15, 1917. We have secured an extension thereof to January 1st, 1918, but cannot have it further extended. Even with this supply of gas there have been shortages upon our lines already, and of course, there will be still greater shortages as the weather gets colder.

Under the circumstances it is utterly impossible to undertake to supply industrial consumers, and, accordingly, the industrial rate will be withdrawn on January 1, 1918.

You are accordingly advised to make preparations to supply your plant with other fuel on or before said date. Meanwhile, and until then, we will do the best we can, although we advise you now that there will be shortages from time to time. From the surplus remaining after supplying our domestic consumers, after January 1st, 1918, we will supply such of our customers as desire, who have gas

engines and appliances, where they are unable to substitute other fuel, but this will be with the understanding, of course, that it is out of the surplus only.

Regretting the necessity of this action, and giving you this notice so far in advance so that you may make the changes in your plant without embarrassment, we are,

Yours very truly,

(Signed) JOHN E. GILL,
President.

2a PENNSYLVANIA EXHIBIT 4.

Offered at p. 149 of Printed Record by Witness Quay.

Warning Letter Sent by the Manufacturers Light & Heat Company to Its Industrial Natural Gas Consumers November 30, 1917.

3 (Copy.)

November 30th, 1917.

GENTLEMEN:

In our letter to you of June 30th, 1917, we notified you that we might not be able to supply gas to our industrial consumers the coming winter, and recommended that you make arrangements for other fuel. On October 9th, 1917, we advised you that we could not supply industrial consumers during the coming winter, and that the industrial classification and rate would be withdrawn after January 1st, 1918.

We regret the necessity for this action. We tried to avoid it. Owing to the termination by expiration of certain contracts for the purchase of gas from other companies, which we cannot renew, even if we attempted to supply all of our consumers the service would be so unsatisfactory as to be of little value.

While we must cancel all of our industrial contracts as of January 1st, 1918, we expect after that date, to have at times considerable quantities of gas, after the domestic business has been supplied, and we are willing to furnish this surplus gas to any of our customers who may desire to use it for special purposes or in especial appliances where other fuel cannot readily be substituted. We hope this surplus will be sufficient to meet the requirements of all our industrial customers who have such special purposes and appliances. New contracts will be forwarded upon application to those who may desire to avail themselves of this service, and application therefor should be made as soon as possible, and before January 1st next. We are preparing the forms for such applications and for such contracts which will be furnished to all who may desire the same. The company would like these applications filed as soon as possible. All applicants for service should state specifically the kind of appliances in which, or the purposes for which, the fuel is desired and the particulars of their claims for special consideration. As soon as practicable after January 1st, and before February 1st, these applications

will be considered and acted upon and when contracts are made, the same will be effective as of January 1st, 1918. Meanwhile, we will do the best we can for all consumers.

Thanking you for your patronage and many courtesies during the years of our business relations, and assuring you of our earnest desire to serve you in the future, as far as possible, I am,

Yours very truly,

(Signed) JOHN E. GILL,
President.

3*a* PENNSYLVANIA EXHIBIT 5.

Offered at p. 149 of Printed Record by Witness Quay.

Warning Letter Sent by the Manufacturers Light & Heat Company to Its Industrial Natural Gas Consumers December 22, 1917.

4 The Manufacturers Light and Heat Company and Affiliated Companies.

General Offices, Columbia Bank Building.

John E. Gill, President.

Pittsburgh, Pa., December 22, 1917.

In accordance with our previous notice, we herewith enclose blank application for natural gas service after January 1st, 1918.

If you desire to avail yourself of this service, kindly fill in all of the data pertaining to your plant, having the application signed by the proper officer of the company and return to this office before January 1st next.

Yours very truly,

(Signed) JOHN E. GILL,
President.

Enclosure.

4*a* PENNSYLVANIA EXHIBIT 6.

Offered at p. 149 of Printed Record by Witness Quay.

Warning Letter Sent by the Manufacturers Light & Heat Company to Its Industrial Natural Gas Consumers July 8, 1918.

5 (Copy.)

July 8th, 1918.

During last winter The Manufacturers Light & Heat Company was unable to furnish its industrial consumers with a sufficient quantity of natural gas to meet their increased and increasing requirements. Anticipating this early last year, we accordingly notified our consumers, and withdrew our industrial classification and rates, but continued

to furnish such service as we could at the old rate out of the surplus after taking care of domestic consumers. As a result, many users of natural gas substituted other fuel in portions of their plants, and were thus enabled to continue operations practically without interruption. Others did not heed the warning and were accordingly compelled to suspend from time to time during the colder weather.

Realizing the importance to our consumers of keeping their plants in operation and that the Government is relying upon the industrial plants in this section to furnish large quantities of necessary material for the prosecution of the war, we feel it to be our duty to again call your attention to the conditions that will, no doubt, prevail during the coming winter.

This company proposes to drill all the wells possible during this summer and will make every effort to obtain by purchase, as well as drilling, as large a quantity of natural gas as can be thus procured. The difficulties encountered in drilling for and obtaining gas are constantly increasing, and wells recently drilled have not been as prolific of a supply as in former years. There is not as much gas procurable by purchase as in former years. The result of our proposed efforts is, of course, problematical, but, judging from past experiences, we hope to approximately furnish as much gas as we were able to supply last winter. Under these circumstances, we again advise you to make preparations during the warm weather for the use of other fuel during the cold weather, so that in case of gas shortage you will not be taken unawares.

We also call your attention, not only to the shortage in the gas supply, but to the increased cost of that obtained, due to the greatly increased cost of labor and material. If such continues, affecting as it does the production, transportation and distribution of gas, we will increase our rates, and therefore, in estimating the cost of fuel, it would be well for all consumers to make their calculations accordingly.

Believing that our country's needs admit of no diminution of effort on the part of every patriotic citizen, we propose to continue to the utmost our efforts to secure the largest possible gas supply, regardless of cost to us, feeling confident that our consumers will appreciate our difficulties and our efforts to overcome them, and help us to bear the burden.

Thanking you for your previous kindly consideration and hoping always to merit the same, we are

Respectfully yours,

JOHN E. GILL,
President.

5a PENNSYLVANIA EXHIBIT 7.

Offered at p. 149 of Printed Record by Witness Quay.

Warning Letter Sent by the Manufacturers Light & Heat Company to Its Industrial Natural Gas Consumers October 29, 1918.

6 The Manufacturers Light and Heat Company and Affiliated Companies.

General Offices, Columbia Bank Building.

H. A. Quay, Assistant Manager.

Pittsburgh, Pa., October 29th, 1918.

GENTLEMEN:

Attached you will find duplicate copy of contract entered into with this company for a supply of gas for such subjects in your plant in which other fuel cannot be readily substituted; this supply to be furnished from the surplus remaining after the requirements of the domestic consumer have been taken care of.

We take this opportunity of again advising you of the necessity of keeping and having on hand at all times, sufficient substitute fuel so that in the event a shortage in the supply of gas does occur, you will have some means whereby your plant can be kept in operation, regardless of the condition of the gas supply.

Attached also you will find information contained in Publication #28 of the United States Fuel Administrator, dated September 25th, 1918, and defining certain classes under which the distribution of natural gas will be made. This is for your information.

Attached also you will find a form in which we have undertaken, per the Rules and Regulations of the Fuel Administrator, to designate the classes under which the different subjects in your plant will receive deliveries. We would suggest that this form be retained and filed for ready reference by you.

Yours truly,

(Signed) H. A. QUAY,
Assistant Manager.

Inclosures.
M. H.

6a PENNSYLVANIA EXHIBIT 8.

Offered at p. 149 of Printed Record by Witness Quay.

Warning Letter Sent by the Manufacturers Light & Heat Company to Its Industrial Natural Gas Consumers January 28, 1920.

7 The Manufacturers Light and Heat Company and Affiliated Companies.

General Offices, Columbia Bank Building.

John E. Gill, President.

Pittsburgh, Pa., January 28th, 1920.

We regret that circumstances over which we have no control compel us to advise you as follows:

The supply of gas is fast diminishing, the cost thereof is becoming greater, the demands of domestic consumers upon our lines is increasing, and our ability to provide them with a reasonably adequate supply has become more and more difficult if not quite impossible. These conditions compel us to curtail the amount of gas to be supplied for industrial purposes, especially such industries which naturally desire and as far as possible are entitled to keep their plants in operation and not be subjected to losses incident to intermittent operation especially during winter weather.

It is our purpose on March 5th, 1920, to cancel your agreement with us for industrial consumption, and if any exception is made it will be only for those units of your plant where other fuel cannot be readily substituted. As we have in the past, so will we in the future, continue our explorations for new gas fields and our operations in developed fields and our purchases of gas, and we expect, particularly during the summer months, when the domestic consumption decreases, to have a considerable quantity of gas available over and above the requirements of our domestic consumers.

If you so desire we would be pleased to negotiate with you a contract for the rendition of such service as we can, especially those having plants with requirements of a special and limited nature. With this in view, we enclose to you herewith a blank form of application which we would be pleased to have you fill out and return in case you desire to enter into such negotiations. It is important that these applications be received by us at the earliest date, so we can make our calculations accordingly and if necessary and possible, apportion our surplus gas to those industries to which we now feel under obligations because they have heretofore been upon our lines.

We cannot convey to you the full significance of our regret that we are compelled to take this step, which regret is only increased by the fact that we heretofore have had your co-operation and patronage.

Yours very truly,

(Signed) JOHN E. GILL,
President.

7a PENNSYLVANIA EXHIBIT 9.

Offered at p. 157 of Printed Record by Witness Quay.

Application Form for Surplus Gas From the Manufacturers Light & Heat Company, January 28, 1920.

8 —— —, ——.

Application from —— —— to the Manufacturers Light & Heat Company.

Subject to the rules and regulations of The Manufacturers Light & Heat Company, and in accordance with your letter of January 28th, 1920, applicant hereby makes application for a supply of Natural Gas for —— Works situated on —— Street, —— (Town) ——(State).

It is understood that this supply is to be furnished from the surplus gas remaining after the requirements of the domestic consumers on your lines have been supplied, and may be discontinued wholly or in part to meet said requirements.

The Natural Gas furnished under this application to be used for manufacturing purposes in the appliances and for the purposes and under the conditions described below:

(Describe specifically.)

.....
.....
.....
.....
.....

So that you may be fully advised as to the peculiar importance of fuel for applicant's work, applicant states:

(Give here any special circumstances entitling you to special consideration. Be specific and particularize.)

.....
.....
.....
.....
.....

That the minimum quantity of gas per hour with which applicant can operate is —— cu. ft.

The maximum amount required per hour in order to operate the plant at its maximum capacity is —— cu. ft.

The minimum amount of gas required for twenty-four (24) hours is —— cu. ft.

The maximum amount of gas required for twenty-four (24) hours is —— cu. ft.

Plant operates — hours daily during the day (night) Summer months.

Plant operates — hours daily during the day (night) Winter months.

Applicant states that in accordance with previous notices, arrangements have been made to substitute other fuel as follows:

(State here what has been done, and if not, why not.)

.....
.....
.....
.....

Kindly submit contract to furnish applicant with gas under the conditions above set forth.

——, ——,
(Name of person or firm.)
By —— ——.

[Endorsed:] No. —. Application from —— —— to the Manufacturers Light & Heat Company for Natural Gas Service. —— —, ——, 192-.

8a PENNSYLVANIA EXHIBIT 10.

Offered at p. 157 of Printed Record by Witness Quay.

Application Form for Surplus Gas From the Manufacturers Light & Heat Company November 30, 1917.

9 —— —, 191-.

Application from —— —— to the Manufacturers Light & Heat Company.

Subject to the rules and regulations of The Manufacturers Light & Heat Company and in accordance with your letter of November 30th, 1917, and previous notices, applicant hereby makes application for a supply of Natural Gas for —— Works situate on —— Street, —— (Town), —— State.

It is understood that this supply is to be furnished from the surplus gas remaining after the requirements of the domestic consumers on your lines have been supplied, and may be discontinued wholly or in part to meet said requirements.

The Natural Gas furnished under this application to be used for manufacturing purposes in the appliances and for the purposes and under the conditions described below:

(Describe specifically:)

.....
.....
.....
.....
.....

So that you may be fully advised as to the peculiar importance of fuel for applicant's works, applicant states:

(Give here any special circumstances entitling you to special consideration, such as supplying the Government with necessary war material, etc. Be specific and particularize.)

.....
.....
.....
.....
.....

That the minimum quantity of gas per hour with which applicant can operate is —— cu. ft.

The maximum amount required per hour in order to operate the plant at its maximum capacity is —— cu. ft.

The minimum amount of gas required for twenty-four (24) hours is —— cu. ft.

The maximum amount of gas required for twenty-four (24) hours is —— cu. ft.

Plant operates — hours daily during the day, night.

Applicant states that in accordance with previous notices applicant has made arrangements to substitute other fuel as follows:

(Here state what has been done, and if not, why not.)

.....
.....
.....
.....

Kindly submit contract to furnish applicant with gas under the conditions above set forth.

—— ——,
(Name of person or firm.)
By —— ——.

[Endorsed:] No. —. Application from —— —— to the Manufacturers Light & Heat Co. for Natural Gas Service. —— ——, 191-.

9a PENNSYLVANIA EXHIBIT 11.

Offered at p. 157 of Printed Record by Witness Quay.

Application Form for Surplus Gas From the Manufacturers Light & Heat Company July 8, 1918.

——— —, 19—.

Application from ——— ——— to the Manufacturers Light & Heat Company.

Subject to the rules and regulations of The Manufacturers Light & Heat Company and in accordance with your letter of July 8th, 1918, and previous notices, applicant hereby makes application for a supply of Natural Gas for ——— Works situate on ——— Street, ——— (Town), ——— State.

It is understood that this supply is to be furnished from the surplus gas remaining after the requirements of the domestic consumers on your lines have been supplied, and may be discontinued wholly or in part to meet said requirements.

The Natural Gas furnished under this application to be used for manufacturing purposes in the appliances and for the purposes and under the conditions described below:

(Describe specifically.)

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

So that you may be fully advised as to the peculiar importance of fuel for applicant's works, applicant states:

(Give here any special circumstances entitling you to special consideration, such as supplying the Government with necessary war material, etc. Be specific and particularize.)

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

That the minimum quantity of gas per hour with which applicant can operate is ——— cu. ft.

The maximum amount required per hour in order to operate the plant at its maximum capacity is ——— cu. ft.

The minimum amount of gas required for twenty-four (24) hours is ——— cu. ft.

The maximum amount of gas required for twenty-four (24) hours is —— cu. ft.

Plant operates — hours daily during the day, night.

Applicant states that in accordance with previous notices applicant has made arrangements to substitute other fuel as follows:

(Here state what has been done, and if not, why not.)

.....
.....
.....
.....

Kindly submit contract to furnish applicant with gas under the conditions above set forth.

—— ——,
(Name of person or firm.)
By —— ——.

[Endorsed:] No. —. Application from —— —— to the Manufacturers Light & Heat Co. for Natural Gas Service. —— —, 19—.

10*a* PENNSYLVANIA EXHIBIT 12.

Offered at p. 158 of Printed Record by Witness Quay.

Requisitions by the Manufacturers Light & Heat Company on the Hope Natural Gas Company for Gas Service During 1919 *and* 1920.

11 Copy.

May 2nd, 1919.

Mr. T. O. Sullivan, Vice President,
Hope Natural Gas Company,
424 Sixth Avenue, Pittsburgh, Penna.

DEAR SIR:

Following the usual yearly custom, wish to say the records of our company show that during the year 1918, we sold to domestic consumers in the

State of West Virginia.....	1,152,652,000 cu. ft.
State of Pennsylvania.....	8,082,208,000 cu. ft.
State of Ohio.....	2,707,305,000 cu. ft.
Total	11,942,165,000 cu. ft.

This was the actual amount of gas necessary in order to supply our domestic consumers during the year 1918. By adding six (6%) per cent to the amount sold, we arrive at the amount of gas deliverable for the year 1919 and 1920, as follows:

To be delivered for use of domestic consumers in the

State of West Virginia	1,221,811,000	cu. ft.
State of Pennsylvania	8,567,140,000	cu. ft.
State of Ohio	2,869,743,000	cu. ft.
Total	12,658,694,000	cu. ft.

In prorating this amount so as to determine the quantity deliverable each month and each day thereof, we have worked out the following tables, based upon the same percentages as used during the year- of 1918 and 1919 and previous years, with the following result:

Month.	Percentage.	Total cubic feet delivered per month.	Average daily delivery, cubic feet.
1919.			
May	6.3	797,498,000	25,726,000
June	5.	632,935,000	21,098,000
July	4.	506,348,000	16,334,000
August	4.	506,348,000	16,334,000
September	4.5	569,641,000	18,988,000
October	7.	886,108,000	28,584,000
November	10.6	1,341,821,000	44,727,000
December	11.8	1,493,726,000	48,185,000

12

1920.			
January	13.	1,645,630,000	53,085,000
February	13.	1,645,630,000	56,746,000
March	11.5	1,455,750,000	46,960,000
April	9.3	1,177,259,000	39,242,000
Total	100%	12,658,694,000	

Inasmuch, however, as February 1920 is a Leap year and the month consists of 29 days instead of the usual 28 days, we would be pleased to have you agree that the daily deliveries for that month in 1920 be placed at 58,772,000 cubic feet.

Believing this to be only fair and thanking you in advance for giving this your usual prompt consideration, I am,

Yours very truly,

H. A. QUAY,
General Manager.

M. H.

12*a* PENNSYLVANIA EXHIBIT 13.

Offered at p. 158 of Printed Record by Witness Quay.

Number of Domesticated, Industrial, and Miscellaneous Consumers and Gas Deliveries by the Manufacturers Light & Heat Company at Bellaire, Ohio, from 1911 *to* 1919.

13 City of Bellaire, O., Only, Year Ended 12/31.

	Consumers.	Deliveries.
1919:		
Domestic	2,934	320,803
Industrial	32	456,295
Miscellaneous	22	6,255
Total	2,988	783,353
1918:		
Domestic	2,895	331,753
Industrial	34	517,377
Miscellaneous	28	6,625
Total	2,957	855,755
1917:		
Domestic	2,848	331,520
Industrial	34	725,584
Miscellaneous	25	7,627
Total	2,907	1,064,731
1916:		
Domestic	2,721	282,080
Industrial	34	901,862
Miscellaneous	29	6,685
	2,784	1,190,627
1915:		
Domestic	2,575	263,554
Industrial	35	785,142
Misce	24	6,933
Total	2,634	1,055,629

	Consumers.	Deliveries.
1914:		
Domestic	2,421	266,526
Industrial	33	789,319
Misce.	23	6,654
Total	2,477	1,062,499
1913:		
Domestic	2,316	243,462
Industrial	32	830,317
Misce.	24	6,658
Total	2,372	1,080,437
1912:		
Domestic	2,190	277,389
Industrial	36	856,983
Misce.	23	7,399
Total	2,249	1,141,771
1911:		
Domestic	2,474	276,849
Industrial	34	833,356
Misce.	23	17,938
	2,531	1,128,143

13a PENNSYLVANIA EXHIBIT 14.

Offered at p. 179 of Printed Record by Witness Quay.

63 *Largest Individual Holdings of Stock of the Manufacturers Light & Heat Company as of March 31, 1920.*

14 The Manufacturers Light & Heat Co.

Individual Holdings as of March 31, 1920.

	Shares.	Shares.	Shares.
	1,500	500	1,180
	8,004	800	502
	900	4,570	3,128
	608	420	11,141
	1,500	590	8,000
	3,708	1,225	6,583
	8,664	3,300	1,022
	1,000	1,237	2,994
	600	500	5,050
	800	451	1,481
	6,500	3,606	3,100
	2,056	1,000	1,000
	2,777	500	2,329
	738	521	4,325
	1,113	2,072	2,443
	415	800	439
	465	2,181	4,715
	1,717	500	1,058
	1,602	815	500
	6,765	660	655
	1,200	1,354	2,200
Totals	52,632	79,734	142,449

Summary.

Total of preceding 63 acs.	142,449	Shrs.
Balance of stock outstanding in 4,107 additional acs.	317,551	"
	460,000	Shrs.
Total number of Stockholders	4,170	

Prepared by me at request of Mr. Quay, and certified as correct.

S. SIEBERT,
Secretary.

June 3, 1920.

14*a* PENNSYLVANIA EXHIBIT 15.

Offered at p. 186 of Printed Record by Witness Sullivan.

Map of the main lines of the Hope Natural Gas Company, the Reserve Natural Gas Company of West Virginia, and the Peoples Natural Gas Company of Pennsylvania as of December 31, 1917.

NOTE.—This was replaced by Pennsylvania Exhibit 39 B.

14*b* PENNSYLVANIA EXHIBIT 16.

Offered at p. 224 of Printed Record by Witness Sullivan.

Contract Between the Hope Natural Gas Company and the Northwestern Ohio Natural Gas Company Dated October 16, 1915.

15 Agreement Between Hope Natural Gas Company and The Northwestern Ohio Natural Gas Company.

Dated —— —, ——.

16 This agreement, made and entered into this 16 day of October, 1915, by and between the Hope Natural Gas Company, a West Virginia corporation, party of the first part, hereinafter styled the Hope Company, and The Northwestern Ohio Natural Gas Company, an Ohio corporation, party of the second part, hereinafter styled the Northwestern Company:

Witnesseth, whereas the Hope Company, by virtue of a certain contract between the Reserve Gas Company, the Union Natural Gas Corporation, Hope Natural Gas Company, The Connecting Gas Company, and T. N. Barnsdall, dated the 11th day of April, 1913, is entitled to have delivered to it at Sugar Grove, Ohio, by the Reserve Gas Company, through the pipe lines of said company and of The Connecting Gas Company, the amounts of gas in said agreement specified upon the terms and conditions therein stated, and

Whereas, the Northwestern Company is the owner of gas distributing plants in the City of Toledo, Ohio, its suburbs, and other cities, towns and villages, in the State of Ohio, and owns a compressor station at or near Sugar Grove, Ohio, and a pipe line or lines running from said compressor station to the City of Toledo, and

Whereas, the Northwestern Company desires to purchase from the Hope Company, and the Hope Company is willing to sell to the Northwestern Company upon the terms hereinafter set forth gas delivered at Sugar Grove through the lines of the Reserve and The Connecting Gas Companies, and

Whereas, the Northwestern Company has heretofore been
17 receiving gas at Sugar Grove under an agreement between the Hope Company and the Northwestern Company made

and entered into the first day of January, 1906, which said agreement expires January 1st, 1916:

Now, the parties hereto have agreed and do hereby agree as follows:

First: The Hope Company will on and after the 1st day of November, 1915, sell to the Northwestern Company, and the Northwestern Company will purchase from the Hope Company out of the amount of natural gas which the Hope Company receives at Sugar Grove under the contract with the Reserve Company and others dated April 11th, 1913, hereinbefore referred to, all the natural gas necessary to fully supply domestic consumers connected or hereafter to be connected with the distributing systems of the Northwestern Company heretofore referred to and particularly in the City of Toledo and its suburbs, and the towns of Perrysburg, Maumee, Bowling Green, North Baltimore, and other towns which on the 1st day of January, 1915, were supplied through the system of the Northwestern Company.

The Hope Company will cause the amounts of gas which it is obligated hereunder to supply to be delivered through the lines of the Reserve Gas Company and The Connecting Gas Company into the lines of the Northwestern Company at the connection between the lines of the Northwestern Company and The Connecting Gas Company at Wheeler Station, Sugar Grove, Ohio, at a gauge pressure of not less than 50 lbs. per square inch, as indicated at the outlet side of the measuring apparatus, where the Northwestern Company will take and receive the same. The obligation herein assumed by the Hope Company is, however, subject to the following limitations:

18 (1) The Hope Company will use its best efforts to secure the performance by the Reserve Company and the other parties to the contract dated April 11, 1913, hereinbefore referred to, of their obligations under said contract, and will not consent to any modification of said contract which might affect the interest of the Northwestern Company hereunder without the consent of the Northwestern Company.

(2) The Hope Company shall not be liable to deliver hereunder in any one day of 24 hours an amount of gas, which, taken together with the amount necessary to supply domestic consumers in Chester Hill, and the Villages of Stockport and Amesville, and the requirements of domestic consumers at Gravel Bank will exceed Thirty Million (30,000,000) cubic feet, unless or until the Hope Company shall, pursuant to the provisions of the ninth paragraph of the contract, hereinbefore referred to, have procured the construction by the Reserve and The Connecting Gas Companies of additional pipe lines to Sugar Grove, but the Hope Company shall not be under any obligation to procure the construction of such additional pipe lines.

(3) It is the intention of this contract that the Northwestern Company shall take and the Hope Company shall furnish out of the amount of gas which the Hope Company receives as aforesaid

at Sugar Grove, all the natural gas necessary to fully supply the domestic consumers of the Northwestern Company on the systems above referred to up to the per diem maximum heretofore fixed; but if an increase in the business of the Northwestern Company should require gas for domestic consumers in addition to the amount which the Hope Company is obligated hereunder to supply to it, or if the gas supply of the Reserve Company should fail, or from
19 other causes beyond the control of the Hope Company, and not merely accidental or temporary, the Hope Company should be unable to fulfill the requirements of the Northwestern Company for its domestic consumers under this contract up to the said per diem maximum, and it is necessary for the Northwestern Company to purchase gas from sources other than from the Hope Company to meet such deficiencies, then in any such event, the amount of gas deliverable by the Hope Company hereunder from April 1st to March 31st, inclusive, of each year thereafter shall be reduced to an amount determinable as follows:

The amount of gas purchased per day by the Northwestern Company from sources other than the Hope Company shall be ascertained for the five maximum demand days in January and the five maximum demand days in February, immediately preceding April 1st of each year, on which such purchases were actually made in order to supply the deficiency in the volume furnished by the Hope Company. The proportion which the amount of gas furnished by the Hope Company on said days, less 5% of the amount of gas so furnished, bears to the total amount of gas purchased on said days from all sources including the Hope Company, shall be the proportion deliverable by the Hope Company hereunder of the supply for the domestic consumers of the Northwestern Company during the ensuing year from April 1st to March 31st inclusive. The total amount deliverable by the Hope Company during such year shall be delivered and taken throughout the days and months of the year according to the following table of percentages as nearly as possible, to-wit:

January	12½%	July	4½%
February	12%	August	4½%
March	11%	September	4¾%
April	8½%	October	7½%
May	7½%	November	10½%
June	4¾%	December	12%

20 with allowable variation for each day's delivery so long as the amount taken in each day is between 80% and 120% of the amount deliverable during such day according to such table, but not exceeding so far as the Hope Company is concerned the per diem maximum hereinbefore established, and an allowable variation for each month so long as the amount taken in such months is between 90% and 110% of the amount deliverable during such month according to such table. Any surplus or deficit in the deliveries for any month above or under the proportion of the domestic supply which the Hope Company is to furnish, as established

according to the manner herein provided shall be adjusted, so far as possible, in the deliveries for the next succeeding month. The allowable wariation in said daily deliveries shall only be made use of in good faith according to the actual variation in the requirements of the domestic consumers of the Northwestern Company, it being understood that the average daily variation during the months of May to October, inclusive, of such year shall not be more than two per cent above or two per cent under the said proportion of the domestic supply deliverable by the Hope Company.

If, however, the Hope Company in any year in the pipe lines as now existing shall have available for delivery to the Northwestern Company at Sugar Grove out of the gas which it receives under its contract with Reserve Gas Company and others, dated April 11th, 1913, an amount of gas in excess of the proportion of the domestic supply deliverable to the Northwestern Company so determined under the preceding provisions of this sub-division (3), the Hope Company shall give written notice thereof to the Northwestern Company on or before the first day of January of such year, with an estimate of the amount of such excess. The Northwestern Com-
21 pany shall have the right to take such excess, provided, that prior to April 1st following such notice, it has given written notice to the Hope Company of its election so to do. In case the Northwestern Company elects to take such excess, the proportion of the domestic supply that the Northwestern Company will take from the Hope Company during the ensuing year commencing April 1st shall be increased accordingly; but in the event that the Northwestern Company does not so elect, the Hope Company during the succeeding fourteen months from April 1st of such year to June 1st of the next year may sell and deliver to others than the Northwestern Company any gas which may be in excess of one hundred and twenty (120%) per cent of the proportion of the domestic supply deliverable by the Hope Company to the Northwestern Company as at that time established under the preceding provisions of this sub-division (3), but this provision is not intended to restrict deliveries during emergencies caused by breakage of lines or other accidental causes.

Nothing in this sub-division (3) contained shall be construed as surrendering the right of the Northwestern Company to the additional supply of gas for its domestic consumers provided for in case the Reserve Gas Company and The Connecting Gas Company lay additional pipe lines to Sugar Grove under the provisions of the contract of April 11, 1913, above referred to.

Second. The Northwestern Company will pay the Hope Company for all gas purchased and taken hereunder as follows: For each one thousand (1,000) cubic feet of gas fifty (50%) per centum of the net price per thousand cubic feet charged domestic consumers by the Northwestern Company, but not less than seventeen and one-half (17½) cents per thousand cubic feet; the said net price is the net price per thousand cubic feet after deducting the discount for prompt payment of consumers' monthly bills.

22 Third. For the purposes of this contract one thousand cubic feet of gas shall be deemed to be one thousand cubic feet of gas, measured under a gauge pressure of ten (10) ounces to the square inch, according to Boyle's "Law for the Measurement of Gas under Varying Pressure", and the amount of gas delivered and the amounts payable therefor shall be computed accordingly.

Fourth. For the purpose of this contract domestic consumers shall be those consumers heretofore classed as "domestic" according to the system of bookkeeping used by the Northwestern Company.

Fifth. The amount of gas sold and delivered hereunder to the Northwestern Company shall be measured at the *pitot* tube or orifice meter measuring station known as Wheeler Station at Sugar Grove maintained by The Connecting Gas Company pursuant to a contract between the Hope Natural Gas Company, the Reserve Gas Company and others hereinbefore referred to, but the Northwestern Company, by its accredited representative shall at all times have access to the station for the purpose of inspecting and testing and checking the readings.

Sixth. The Northwestern Company shall on or before the 20th day of each month furnish to the Hope Company a statement showing the amount of gas ascertained during the previous month to have been delivered to the domestic consumers on or delivered through the lines of the Northwestern Company, and whenever called upon so to do by the Hope Company shall furnish to the Hope Company a statement showing the cities, towns and villages in which it is supplying gas to domestic consumers, and the number of domestic consumers in each of said cities, towns and villages.

23 All gas supplied by the Northwestern Company to domestic consumers shall be measured by meters in all cases where measurement by meters is practicable. In all cases where measurement by meter is not practicable the amount of gas delivered shall be ascertained by the most accurate practicable method. All meters shall be read at least once a month. All books and records of the Northwestern Company relating to the amount of gas received and the amount of gas delivered to domestic consumers, and the prices charged therefor, shall at all times be open to the inspection of the representatives of the Hope Company. If the Northwestern Company makes or maintains any connection or connections between its lines and the lines of any other distributor of gas, it shall give prompt written notice of the same to the Hope Company; and whenever the Northwestern Company delivers gas through such a connection or receives gas through such a connection from others than the Hope Company to make up a deficiency in the supply as hereinbefore provided, an accurate measurement and record of all such deliveries and receipts shall be kept by the Northwestern Company, and the daily amounts and places of the same and the names of such vendors and other distributors shall be added to the above statements to be rendered by the Northwestern Company to the Hope Company, and the Hope Company by its accred-

ited representatives shall at all times have access to such meters and records for the purpose of inspecting, testing and checking the readings and examining the records.

Seventh. The amounts payable by the Northwestern Company for natural gas sold and delivered to it during any month shall be paid to the Hope Company on or before the 20th day of the succeeding month.

24 Eighth. In case any amount due and payable by the Northwestern Company to the Hope Company for gas sold and delivered hereunder is not paid in thirty days after the same is due and payable, after demand has been made by the Hope Company therefor, the Hope Company shall have the right, without terminating or canceling this contract, to suspend the delivery of gas hereunder until all amounts due to it are paid, or on its option, on giving sixty days' notice to the Northwestern Company of its intention so to do, may terminate this contract.

Ninth. This contract shall on the 1st day of November, 1915, supersede the contract dated January 1st, 1906, hereinbefore referred to, and shall continue so long as by the terms of the agreement with the Reserve Gas Company and other parties hereinbefore referred to, the Hope Company is entitled to the delivery of natural gas at Sugar Grove through the lines of the Reserve and Connecting Gas Companies.

Tenth. A copy of the contract of April 11th, 1913, between the Hope Natural Gas Company et al. hereinabove referred to, duly certified as correct and authenticated by the Secretary of the Hope Natural Gas Company, is hereto attached for identification and reference.

Eleventh. This agreement shall bind the parties hereto, their respective successors and assigns.

25 In witness whereof, the parties hereto have hereunto caused their corporate names to be signed and their corporate seals to be affixed on the day and year first above written.

HOPE NATURAL GAS COMPANY. [SEAL.]
(Sgd.) By JOHN G. PEW,
Vice-President.

Attest:
CHRISTY PAYNE,
Secretary.

THE NORTHWESTERN OHIO NATURAL GAS COMPANY,
By GEO. W. CRAWFORD,
Vice-President.

Attest:
[SEAL.] H. C. REESER,
Secretary.

26 STATE OF PENNSYLVANIA,
County of Allegheny, ss:

Before me, a Notary Public in and for said County, personally appeared Geo. W. Crawford, President of The Northwestern Ohio Natural Gas Company, the corporaton which executed the foregoing instrument, who acknowledged that the seal affixed to the said instrument is the corporate seal of the said corporation; that he did sign and seal said instrument as President, in behalf of said corporation and by authority of its Board of Directors; and that said instrument is the free act and deed of the said The Northwestern Ohio Natural Gas Company.

In testimony whereof, I have hereunto subscribed my name at Pittsburgh, Pa., this 16th day of October, A. D. 1915.

WALTER W. RATHBUN, [SEAL.]
Notary Public.

My Commission expires February 21, 1919.

STATE OF PENNSYLVANIA,
County of Allegheny, ss:

I, Walter W. Rathbun, a Notary Public of said County of Allegheny, do certify that John G. Pew personally appeared before me in my said County, and being by me duly sworn, did depose and say that he is the Vice-President of the Hope Natural Gas Company, one of the corporations described in the writing above, bearing date the 16th day of October, 1915, authorized by said corporation to execute and acknowledge deeds and other writings for said corporation, and that the seal affixed to the said writing is the corporate seal of said corporation, and that the said writing was signed and sealed by him on behalf of said corporation, by its authority duly given; and the said John G. Pew acknowledged the said writing to be the act and deed of said corporation.

Given under my hand and official seal this 16th day of October, A. D. 1919.

WALTER W. RATHBUN, [SEAL.]
Notary Public.

My Commission expires February 21, 1919.

27 Reserve Gas Company, party of the first part.
Union Natural Gas Corporation, party of the second part.
Hope Natural Gas Company, party of the third part.
The Connecting Gas Company, party of the fourth part.
T. N. Barnsdall, party of the fifth part.

28 This agreement, Made and entered into this 11th day of April, A. D. 1913, by and between Reserve Gas Company, a West Virginia corporation, hereinafter called "Reserve, party of the first part; Union Natural Gas Corporation, a Delaware corporation, hereinafter called "Union", party of the second part; Hope Natural Gas Company, a West Virginia corporation, hereinafter

called "Hope", party of the third part; The Connecting Gas Company, an Ohio corporation, hereinafter called "Connecting", party of the fourth part; and T. N. Barnsdall, of Pittsburgh, Pennsylvania, party of the fifth part:

Whereas, said T. N. Barnsdall, Hope and Reserve entered into two written agreements, each bearing date the 20th day of June, 1902, for the production, transportation and sale of natural gas, and the rights and interests of said T. N. Barnsdall in the said two agreements were subsequently sold and assigned by him to Union; and

Whereas, the above named agreements have been modified from time to time by supplementary contracts between the parties hereto; and

Whereas, it is deemed advisable that a new agreement be
29 made and entered into between the parties hereto, and that the contracts above referred to, and certain existing contracts hereinafter enumerated be cancelled and annulled; and

Whereas, Reserve owns the gas rights or leasehold gas rights in about 55,600 acres of land in Harrison and Lewis Counties, West Virginia, together with 352 producing gas wells thereon, field lines and a compressing station; also two gas transportation trunk lines, each 12 inches in diameter, extending from the field in a northwesterly direction to Schultz, Pleasants County, West Virginia; also two trunk lines 16 inches in diameter, extending in a northwesterly direction from Schultz, West Virginia, to the south-east bank of the Ohio River; also three 10 inch pipe lines crossing the river to its northwest bank, which river crossings are about to be increased by the construction of three additional 10 inch pipe lines, all ending at a point known as Gravel Bank on the Ohio state line, and

Whereas, Connecting owns two gas transportation trunk lines each 16 inches in diameter, connected to the said river crossing lines of Reserve Gas Company at Gravel Bank on the northwest shore
30 of the Ohio River, and extending in a northwesterly direction, passing near Chesterhill, Ohio, and Jacksonville, Ohio, to Sugar Grove, and

Whereas, Hope and Union have heretofore been buying from Reserve natural gas which has been transported by Reserve through its pipe lines in the State of West Virginia to the junction with the lines of Connecting at Gravel Bank on the Ohio State line, and by Connecting through its lines in Ohio for delivery to Union or parties designated by it at Jacksonville and Sugar Grove, and to Hope or parties designated by it at or near Gravel Bank, Chesterhill and Sugar Grove:

Now, therefore, this agreement witnesseth: That the parties hereto, for and in consideration of the sum of One Dollar to each of the others in hand paid by each of the parties hereto, at and before the sealing and delivery hereof, the receipt of which is hereby acknowledged, and of the covenants and agreements herein-
31 after contained by each of the parties hereto to be well and truly kept and performed, have covenanted and agreed, and by these presents do covenant and agree:

1. Each of the following contracts is hereby terminated and cancelled to take effect on April 11th, 1913, on which day it is understood and agreed that the cancellation thereof shall be duly noted upon the original contract in each case, namely:

Agreement dated the 20th day of June, 1902, wherein T. N. Barnsdall is party of the first part, Hope Natural Gas Company party of the second part, and Reserve Gas Company party of the third part.

Agreement dated the 20th day of June, 1902, in which Reserve Gas Company is party of the first part, T. N. Barnsdall, party of the second part, and Hope Natural Gas Company party of the third part.

Agreement dated the 31st day of March, 1904, wherein Reserve Gas Company is party of the first part, Union Natural Gas Corporation party of the second part, and Hope Natural Gas Company party of the third part.

Two agreements each bearing date the 2nd day of February, 1905, in which Reserve Gas Company is party of the first part, Union Natural Gas Corporation party of the second part, and Hope Natural Gas Company party of the third part.

Agreement dated January 30th, 1907, in which Reserve Gas Company is party of the first part, Union Natural Gas Corporation party of the second part, Hope Natural Gas Company Party of the third part, and The Connecting Gas Company party of the fourth part.

Agreement dated September 3, 1907, in which Reserve Gas Company is party of the first part, Union Natural Gas Corporation, party of the second part, and Hope Natural Gas Company, partly of the third part.

Agreement dated the 24th day of October, 1908, in which Union Natural Gas Corporation is party of the first part, and Reserve Gas Company party of the second part.

32 Agreement dated November 29, 1912, in which Reserve Gas Company is party of the first part, Union Natural Gas Corporation party of the second part, Hope Natural Gas Company party of the third part, and The Connecting Gas Company party of the fourth part.

It is mutually understood and agreed that the only contracts, agreements or understandings between the parties hereto, or any of them, to which Hope, Reserve and Connecting is a party, which are not cancelled and superseded hereby are those enumerated in Schedule "A" hereto annexed.

2. Whenever in accordance with the provisions of this contract a stated amount of gas is to be taken in any one year, or gas is to be taken at a specified rate per annum, a proportion of such yearly amount shall be taken in each month of such year according to the following table of percentages, in which the said proportion to be taken in each month is specified, viz:

May	7½%
June	4¾
July	4½
August	4½
September	4¾
October	7½
November	10½
December	12
January	12½
February	12
March	11
April	8½

3. Between the date hereof and the first day of November, 1913, Union shall purchase and take from Reserve natural gas at the rate of 9,260,000,000 cubic feet for the year; during said period
33 Hope shall purchase and take from Reserve all the natural gas necessary to enable Hope to supply the requirements of The Northwestern Ohio Natural Gas Company under the existing contract between Hope and said company, or any other contract that may hereafter be made by Hope to supply said Company. Hope shall also have the option of purchasing and taking from Reserve between the date hereof and November 1st, 1913, an amount of natural gas not exceeding an amount which added to the amount taken by it to supply the requirements of The Northwestern Ohio Natural Gas Company and the requirements of its customers at Chesterhill and Gravel Bank shall equal the amount taken by Union from Reserve during the same period, but the total amount which Hope shall be entitled to take on any one day at Sugar Grove, Chesterhill and Gravel Bank shall not aggregate more than thirty million cubic feet.

4. During the year commencing November 1st, 1913, and expiring October 31st, 1914, and during each and every subsequent year of the continuance of this contract, Hope and Union respectively shall purchase and take from Reserve, and Reserve shall sell and deliver natural gas in the following amounts:

Union shall purchase and take and Reserve shall sell and deliver to it ten billion cubic feet and such additional amount as shall be specified in the notice hereinafter provided for.
34 During each year until the year commencing November 1st, 1917, Hope shall purchase and take and Reserve shall sell and deliver to it ten billion cubic feet and such additional amount as shall be specified in the notice hereinafter provided for, and during the year commencing November 1st, 1917, and each subsequent year fifteen billion cubic feet and such additional amount as shall be specified in the notice hereinafter provided for.

But the obligations of Reserve hereunder to sell and deliver gas are limited to the amount which it has available for delivery as defined in the 8th paragraph of this agreement, and shall not in the case of Union exceed twelve billion cubic feet in any one year, and

shall not in the case of Hope exceed eighteen billion cubic feet in any one year.

5. On or before the 1st day of May, 1913, and on or before the 1st day of May in each subsequent year, Union and Hope shall each give written notice to Reserve specifying the amount of gas which it will require hereunder in the year commencing November 1st following such yearly notice.

6. The amount to be taken during any year shall be taken during the different months thereof according to the tables of percentages hereinbefore set forth, and the amount to be taken each month shall be taken throughout the month in approximately equal daily amounts, provided, however, that Union and Hope shall each have the right to reduce or increase the amount to be taken by it during any month so long as the amount taken is between 90% and 110% of the amount deliverable during such month, determined as above, and shall have the right to increase or reduce the amount of gas to be taken on any day of the month so long as the amount taken in each day is between 80% and 120% of the amount deliverable during such day determined as above. It is understood, however, that each of said companies must purchase and take during the six summer months beginning May 1st in each year at least one half as much gas as it took during the preceding six winter months, even though in the case of Union the amount which it is thereby required to take during the year is made to exceed twelve billion cubic feet, and in the case of Hope the amount which it is thereby required to take during the year is made to exceed eighteen billion cubic feet.

7. The gas to be taken by Union shall be delivered at Sugar Grove and Jacksonville through the lines of Connecting to Union or to any company or companies designated by Union; the gas to be taken by Hope shall in part be delivered to it through the lines of Connecting at the following places: (*a*) at Sugar Grove for the purpose of fulfilling the requirements of The Northwestern Ohio Natural Gas Company under the contract now existing, or any contract that may hereafter be made by Hope to supply said company, or any other company at that point; (*b*) At Chesterhill for the requirements of The River Gas Company in supplying Chesterhill and the village of Stockport; and (*c*) at Gravel Bank for the requirements of local consumers; but the amount of gas to be delivered to Hope through the lines of Connecting at the three delivery points above named, shall not exceed the maximum of thirty million cubic feet in any one day of 24 hours. The balance of the amount of gas to be taken by Hope shall be delivered to it (*d*) at a central point or points in Reserve's gas field; (*e*) at the delivery end of the new line or lines to be constructed by Reserve and Connecting, or by Reserve alone, upon the demand of Hope as hereinafter provided.

8. Reserve will use reasonable diligence in developing and drilling upon its gas leases and properties for the purpose of obtaining the gas necessary to fulfill its obligations hereunder, and for the above

purpose will build, maintain and provide in good order, condition and manner the necessary compressor stations and gathering lines connecting its wells with the same, and also will use reasonable diligence in obtaining and developing new gas leases and new contracts for gas when the same become necessary and available in order to enable it to deliver gas under the terms of this contract, but nothing herein contained shall obligate Reserve to extend,
37 develop or drill gas leases or to construct compressor stations or pipe lines, or to keep in force existing leases except so far as it is reasonably profitable for it so to do. Whenever Reserve, although it is duly performing its obligations in this paragraph contained, has not available for delivery the full amount of gas to which Union and Hope are entitled under the provisions hereof, Union and Hope shall be entitled to require Reserve to deliver only the amount which it has available for delivery, and Hope shall be entitled to require that 3/5 of the total amount which Reserve has remaining available for delivery from all sources shall be delivered to it, and Union shall have the right to require the delivery to it of 2/5 of said amount. This contract shall continue until Reserve no longer has available for delivery gas in marketable quantities sufficient to enable it to continue in business without loss.

9. Reserve will construct one additional sixteen inch pipe line from its field to Schultz, provided, that Union serves written demand upon it a sufficient time prior to November 1st, 1915, to enable it, by the exercise of reasonable diligence, to complete the construction of said line on or before that date.

38 Hope shall have the right at any time to require Reserve, or Reserve and Connecting, to construct an additional line or additional lines extending from the field of Reserve to such point or points, and having such capacity, as Hope may designate, provided, that the capacity of said line or lines shall not exceed the amount by which the daily capacity of the lines from the field of Reserve to Sugar Grove then existing, exceeds fifty million cubic feet, and provided, that the cost thereof shall not exceed the cost of then constructing a line from the field of Reserve to Sugar Grove having a capacity equal to the amount by which the daily capacity of the lines from the field of Reserve to Sugar Grove then existing exceeds fifty million cubic feet per day. If any such additional line is constructed to Gravel Bank, Chesterhill or Sugar Grove, the provisions of the 7th paragraph and the 3rd paragraph hereof, limiting the amount of the daily deliveries to Hope at those points to thirty million cubic feet, shall have no application to any amount delivered to it through such additional pipe line.

In case Hope shall serve written notice upon Reserve or upon Reserve and Connecting, requiring it or them to construct any such pipe line, Reserve in the one case, and Reserve and Connecting in the other, will with all due diligence comply with the said de-
39 mand, it being understood that any line built in West Virginia shall be built by the Reserve and any line built in Ohio shall be built by the Connecting.

10. In case either Reserve or Connecting in order to carry out its obligations hereunder, requires to obtain money by borrowing the same, or by increasing its capital stock or otherwise, Union will subscribe for and take one half of the stock, bonds or evidences of indebtedness issued for the purpose of obtaining such money, and Hope will subscribe for and take the other half of such stock, bonds or evidences of indebtedness.

11. The price per thousand cubic feet for gas sold by Reserve to Hope and Union shall be as follows:

Delivered in the year	In the field.	At Sugar Grove, Jacksonville, Chesterfield, Gravel Bank, or delivery end of line that may be constructed on demand of Hope, as hereinbefore provided.
1913	.....	.....
1914	.....	.....
1915	.....	.....
1916	.....	.....
1917	.....	.....
1918	.....	.....
1919	.....	.....
1920	.....	.....
1921	.....	.....
1922	.....	.....
1923	.....	.....
1924	.....	.....

and for the period beyond the year 1924 to remain at the price last above named.

40 It is understood and agreed that all of the prices above enumerated are based upon a delivery of the gas by Reserve after the gas has been compressed by it in its compressor stations.

12. Connecting agrees to receive, transport and deliver all the gas which in accordance with the provisions hereof is to be delivered through the lines of Connecting; such gas shall be transported for the same charge, viz: — cents per thousand cubic feet, and, excepting as hereinafter provided, upon the same terms and conditions as are specified in the written contract dated March 31st, 1904, between Reserve and Connecting, under and by virtue of which gas is at present being transported through the lines of Connecting; the said charge of — cents per thousand cubic feet shall be paid by Reserve monthly on or before the 25th day of the month following that in which the gas was transported.

13. Connecting agrees to maintain at its own cost and expense and operate its Pitot tube measuring station at Sugar Grove, and to erect and maintain at its own cost and expense recording Pitot tube or orifice meter measuring devices for the accurate measurement of all gas to be delivered out of its lines at Jacksonville, Chesterhill

and Gravel Bank; and Connecting further agrees to keep its
41 lines, connections and the measuring stations at all times in a condition of good repair to prevent any loss of gas in its transmission and measurement and to accurately account for the gas carried and delivered by it.

14. Reserve will at its own expense erect and maintain in good order and repair and operate all such Pitot tube measuring stations or recording orifice meters as may be necessary to accurately measure all gas delivered to Hope in the field; and at the terminal of the line or lines to be constructed upon the demand of Hope, a similar station or meter, or stations or meters, will be erected, maintained and operated by Reserve, if Reserve constructs and owns the entire line, or by Connecting if the terminal of said line is constructed, owned and operated by Connecting.

15. The gas to be sold and delivered under this agreement and measured as aforesaid, shall be computed upon a basis of a pressure of 10 ounces to the square inch above 14.4 pounds atmospheric pressure according to Boyle's Law for the measurement of gas at varying pressures, without correction for temperature or barometric conditions.

16. If either party to this contract fails to perform any obligations herein assumed by it, and such failure is due to Acts of God, or to a public enemy, strikes, riots, injunctions or other inter-
42 ferences through legal proceedings, breakage or accident to machinery or lines of pipe, washouts, earthquakes, storms, freezing of lines or wells, sudden partial or entire failure of gas wells, or any cause beyond its control, or is caused by the necessity of making repairs or alterations in machinery or lines of pipe, such failure shall not be deemed to be a violation by such party of its obligations hereunder; but such party shall use due diligence to again put itself in position to carry out all of the obligations which by the terms hereof it has assumed.

17. Connecting shall furnish to Reserve on or before the 8th day of each month, and Reserve shall furnish to Hope and Union on or before the 10th day of each month, a statement showing the amount of gas delivered to it during the preceding month, and Hope shall pay for the gas delivered to it, and Union shall pay for the gas delivered to Union, on or before the 25th day of the month in which such statement is furnished. If either party shall be in default in any payment for the period of 15 days, Reserve shall have the right without cancelling this contract or waiving any of its rights hereunder, or prejudicing the rights of any other party, to suspend the delivery of gas hereunder to the party in default, and to re-
43 quire Connecting to shut off such supply of gas from such party in default until all amounts due to Reserve are paid with interest at 6 per cent from the time such amounts are due.

18. Union and Hope shall each have the right at any reasonable time or times by duly designated agents to examine the books of

accounts of Reserve and of Connecting, and all records relating to the delivery of gas by either of said companies, and the measurement of gas so delivered, and to inspect and test any and all pipes, stations, appliances and measuring devices used by Reserve and Connecting.

In witness whereof the corporations parties hereto have hereunto caused their corporate seals to be affixed and the same to be attested by their respective Presidents or Vice Presidents and Secretaries, and the said T. N. Barnsdall has hereunto set his hand and seal the day and year first above written.

RESERVE GAS COMPANY, [SEAL.]
By E. P. WHITCOMB,
Vice President.

Attest:
CHRISTY PAYNE,
Secretary.

HOPE NATURAL GAS COMPANY, [SEAL.]
By JOHN C. PEW,
Vice President.

Attest:
CHRISTY PAYNE.

44 UNION NATURAL GAS CORPORATION,
By E. P. WHITCOMB,
Vice President.

Attest:
[SEAL.] W. R. HADLEY,
Secretary.

THE CONNECTING GAS COMPANY, [SEAL.]
By JOHN G. PEW,
Vice President.

Attest:
CHRISTY PAYNE,
Secretary.

T. N. BARNSDALL. [SEAL.]

Witness:
——— ———.

E. P. W.
J. G. P.

45 It is hereby certified that the within copy of the contract of April 11, 1913, between the Hope Natural Gas Company, Reserve Gas Company, Union Natural Gas Corporation, The Connecting Gas Company, and T. N. Barnsdall, is a correct copy excepting only that the within copy omits the prices which are enumerated in the eleventh and twelfth paragraphs of the original contract, and omits the schedule recited in the first paragraph of the original

contract and annexed to such original contract under the title "Schedule A, Instruments not Cancelled."

Certified this 16 day of October, 1915.

(Sgd.) CHRISTY PAYNE,
Secretary Hope Natural Gas Company.

46 [Endorsed:] Copy. #2762. Miscellaneous Files. Agreement Hope Natural Gas Company and The Northwestern Ohio Natural Gas Company. Dated: —— —, ——.

46*a* PENNSYLVANIA EXHIBIT 17.

Offered at p. 225 of Printed Record by Witness Sullivan.

Contract Between the Hope Natural Gas Company and the Peoples Natural Gas Company Dated May 1, 1911.

47 & 48 Copy.

Gas Purchase Agreement, Hope Natural Gas Company to Sell to The Peoples Natural Gas Company.

Dated May 1st, 1911.

49 This agreement, made and entered into in duplicate this 1st day of May A. D. 1911 by and between the Hope Natural Gas Company, a West Virginia corporation, hereinafter called the "Hope Company," party of the first part, and The Peoples Natural Gas Company, a Pennsylvania corporation, hereinafter called the "Peoples Company," party of the second part;

Witnesseth: That whereas, the Peoples Company is selling and distributing natural gas in the City of Pittsburgh, Pennsylvania, and in other cities, towns and villages in Western Pennsylvania, and is entitled to maintain and extend its pipe lines and deliveries of natural gas throughout the Counties of Greene, Washington, Beaver, Allegheny, Fayette, Westmoreland, Jefferson, Indiana, Armstrong, Clarion, Cambria, Somerset, Blair and Huntington, in said State, and

Whereas, the Peoples Company owns and maintains pipe lines to the State line between the States of Pennsylvania and West Virginia with a gas pumping station at Brave, Greene County, Pennsylvania, and a gas pumping station at Imperial, Allegheny County, Pennsylvania, and

50 Whereas, the gas properties and wells owned by the Peoples Company in the State of Pennsylvania have not been capable for a number of years of supplying a sufficient volume of gas to satisfy the requirements of its markets, so that the Peoples Company has been purchasing from the Hope Company at the State line between the States of Pennsylvania and West Virginia a considerable quantity of gas, at prices and upon terms agreed upon verbally, and

Whereas, the Hope Company owns or holds under lease extensive tracts of gas producing territory in the State of West Virginia and is engaged in the business of producing natural gas and purchasing natural gas from other producers and in selling and delivering the same to consumers in that State and to other distributing
51 companies, and

Whereas, the parties hereto desire to continue their traffic in natural gas at the same points of delivery heretofore established and herein described, but upon terms and prices as herein stipulated:

Now therefore, in consideration of the premises, and of the mutual covenants hereinafter contained, the parties hereto have agreed and do hereby agree as follows:

First. It is mutually understood and agreed that all the rights of the parties hereto in respect to natural gas sold and delivered by the Hope Company to the Peoples Company on and after the 1st day of May, 1911, shall be ascertained and determined by and in accordance with the provisions of this agreement.

Second. The Hope Company undertakes and agrees during the continuance of this contract to sell and deliver to the Peoples Company, and the Peoples Company undertakes and agrees to purchase and take from the Hope Company

(*a*) All the natural gas requisite for the supply of the con-
52 sumers of the Peoples Company paying domestic rates and for the supply of the consumers paying domestic rates of distributing companies supplied with natural gas by the Peoples Company;

(*b*) Such amounts of natural gas as may be requisite to fulfill contracts made with the consent and approval of the Hope Company by the Peoples Company or companies which it supplies with natural gas, for the sale of gas at special rates for manufacturing and special purposes, after the Peoples Company has first sold and delivered from gas wells owned or controlled by it, the amounts of natural gas which it is entitled to market therefrom as set forth in the fourth paragraph hereof.

Provided, however, that the Hope Company shall not be obligated to sell and deliver, or the Peoples Company to purchase and take gas in excess of the amounts currently required for the purposes aforesaid, and that the Hope Company cannot be required to deliver gas in excess of the amount which it has available for delivery as defined in the twenty-first paragraph hereof.

53 Third. The requirements of consumers upon the lines of the Peoples Company and the companies which it supplies with natural gas, paying domestic rates, shall be fully supplied from the gas delivered hereunder in preference to manufacturers or other special consumers purchasing gas for manufacturing or other special purposes, and the Hope Company shall be required to supply gas to be used for manufacturing purposes only where the same is to be sold under special contracts which have first been submitted to and

approved in writing by the Hope Company and which expressly provide that natural gas will be supplied thereunder only in so far as the same is not necessary to meet the requirements of said consumers paying domestic rates.

Fourth. The amount to be delivered and purchased hereunder from January 1st, 1911, to December 31st, 1911, inclusive, is hereby fixed at 18½ billion cubic feet, of which total amount 5½ billion cubic feet is deliverable as the amount of gas for consumers paying domestic rates. Not less than thirty days prior to January 1st in each year during the continuance of this contract, the Managers of the parties hereto shall, if possible, agree upon the amount
54 that will be required by the Peoples Company for consumers paying domestic rates during the year commencing on the January 1st succeeding the time of such agreement, and shall if possible, also agree upon the amount which the Peoples Company shall require from the Hope Company in the same year (over and above the gas from wells owned or controlled by the Peoples Company) to comply with the special contracts which the Hope Company has approved for the sale of gas for manufacturing and other special purposes; said Managers shall, if possible, also agree upon the proportion of such total amounts deliverable during each month of such year (*a*) for said domestic purposes, and (*b*) for said manufacturing and special purposes. If such agreement is reached, the amounts agreed upon and the proportions for each month agreed upon shall be the amounts of natural gas deliverable hereunder during the year as to which such agreement is made, unless the parties hereto shall mutually agree upon larger amounts, in which case such larger amounts shall be the amounts deliverable hereunder during such year; in case the Managers of the parties hereto are unable to
55 agree upon the amounts deliverable by the Hope Company to supply the Peoples Company during any year or the months of any year, and no agreement is made between the parties hereto as to the amounts to be delivered during such year, the amounts deliverable hereunder during such year shall be determined as follows, viz:

(*x*) The amount deliverable during each year for the term from January 1st, 1912, to December 31st, 1916, for its consumers paying domestic rates, shall be the amount which was supplied by the Peoples Company to consumers paying domestic rates upon its lines and the lines of companies supplied by it with natural gas during the previous year, plus six per cent. of such amount; and the amount deliverable each year after December 31st, 1916, for said consumers paying domestic rates, shall be the amount supplied for like purposes during the previous year, with the same percentage of increase or decrease as was shown in such previous year by the regular growth or contraction of the volume of gas supplied to consumers paying domestic rates (but this provision is at no time to be so construed as to relieve the Hope Company from its obligation to supply
56 all of the natural gas required for all such consumers paying domestic rates, consistent with its available supply as defined in this contract); and the proportion of the total amount deliverable

during each month of each year during the whole term of this contract shall be as follows:

Month.	Per cent.	Month.	Per cent.
January	12	May	8
February	12	June	5
March	11	July	5
April	9	August	5
November	10	September	5
December	11	October	7

(*y*) The amount deliverable to supply manufacturing and other special purposes during such year by the Hope Company, and the amount which the Peoples Company shall be entitled to take from wells owned or controlled by the Peoples Company (in the event of failure of Managers to agree as aforesaid) shall be calculated
57 upon the following basis, viz:

In the months of January and February, the Peoples Company shall have the right to market for manufacturing and other special purposes all of the gas which it desires or is able to produce from wells owned or controlled by it, and the amount deliverable by the Hope Company in said two months shall be the gas required by the Peoples Company over and above such production; the amount actually delivered by the Hope Company to the Peoples Company in the said months of January and February shall be 20 per cent. of the whole amount deliverable by the Hope Company in the twelve months of such calendar year; and the proportion of the total amount deliverable by the Hope Company for said manufacturing and other special purposes during each month of such year shall be as follows, viz:

58

Month.	Per cent.	Month.	Per cent.
January	10	May	8
February	10	June	8
March	9	July	7
April	8	August	7
November	8	September	8
December	9	October	8

In the month of March and in all subsequent months of such calendar year, the Peoples Company shall have the right to market from wells owned or controlled by it such gas as it requires for its markets over and above the amounts deliverable by the Hope Company as hereinbefore determined.

Fifth. The amounts deliverable each month shall be delivered and taken throughout the month so that approximately equal amounts shall be delivered and taken each day, provided, however, that the Peoples Company shall have the right to reduce or increase the amount to be delivered during any month so long as the
59 amount delivered and taken is between 95 per cent. and 105 per cent. of the amount deliverable during such month, de-

livered as hereinbefore provided, and shall have the right to increase or reduce the amount of gas to be delivered on any day of any month so long as the amount delivered and taken in said day is between 90 per cent. and 110 per cent. of the average per day deliverable during the month, determined as hereinbefore provided; it being understood that the Peoples Company shall take during each year the full amount deliverable during such year, determined as hereinbefore provided, and shall take each month at least 95 per cent. of the amount deliverable during such month.

In order to protect the Peoples Company from loss by reason of the right reserved in the usual contracts made with manufacturing and other special consumers permitting such consumers to shut down their works at any time, it is agreed that during any period when through strikes, panics or business depression, there occurs such a shut-down among consumers named in the contracts approved by the Hope Company, as to amount to a decrease of 10 per cent. or more in the amount of gas sold and delivered by the Peoples Company to such consumers, there shall be a like reduction in
60 the amount of gas which the Peoples Company is required to take for such year and each month of such year from the Hope Company for manufacturing and other special purposes.

Sixth. The Peoples Company undertakes and agrees that it will pay to the Hope Company monthly for the natural gas deliverable hereunder for consumers paying domestic rates, the following rates and prices for each one thousand cubic feet, viz:

From May 1st, 1911, to December 31st, 1916, inclusive, 15 cents;

From and after January 1st, 1917, a price each month equal to 55 per cent. of the average price realized each month by the Peoples Company for natural gas sold to domestic consumers, provided, however, that the price paid to the Hope Company from and after May 1st, 1916, for each successive period for five years, shall not be less than 110 per cent. of the highest price received by the Hope Company in the last preceding period of five years.

The Peoples Company undertakes and agrees that it will pay
61 to the Hope Company monthly upon the basis of the measurements recorded by the said measuring devices for all gas sold and delivered for manufacturing or special consumers (who are buying gas from the Peoples Company under special contracts made with the approval of the Hope Company as herein set forth) a price for each one thousand cubic feet of gas equal to 65 per cent. of the average price per thousand cubic feet charged from month to month by the Peoples Company for gas sold to consumers other than consumers paying domestic rates. The amount of gas so sold to consumers other than to consumers paying domestic rates shall be ascertained each month by deducting the amounts deliverable hereunder for consumers paying domestic rates from the total registration of the said measuring devices.

Beginning with and during the time hereafter that the Peoples Company is unable to secure from its own gas properties and from the Hope Company a supply of natural gas sufficient for the requirements of the Peoples Company for all of the consumers paying

domestic rates on distributing systems owned or supplied with natural gas by it, and the Peoples Company is compelled to and does supplement the supply with manufactured gas, the price
62 thereafter to be paid to the Hope Company during the continuance of this contract shall be 25 cents per thousand cubic feet for all natural gas delivered by the Hope Company to the Peoples Company as shown by the total registration of the measuring devices.

Provided, always, that in case any tax or assessment is hereafter imposed upon the natural gas for use in or export from the State of West Virginia, or on the sale or exportation from the State of West Virginia, of natural gas, or in any other manner so as to constitute in effect a charge upon the gas delivered hereunder, the amount of such tax or assessment or charge shall be borne by the Peoples Company in so far as it relates to or is apportionable to the natural gas deliverable hereunder; and in the event that the Hope Company is required to pay the same the amount thereof shall be paid by the Peoples Company to the Hope Company in addition to the prices above stated.

Seventh. The natural gas to be sold and delivered hereunder shall be delivered by the Hope Company to the Peoples Company at the boundary line between the states of West Virginia
63 and Pennsylvania, at the points where the lines of the Hope Company now connect with the lines of the Peoples Company, or at such other points as may be mutually agreed upon. The points of delivery at the date hereof are as follows: at the State Line about one half mile north of Bula, West Virginia, where a 10 inch line and a 16 inch line of the Hope Company deliver into a 10 inch line and a 16 inch line of the Peoples Company and the gas is measured by Pitot tubes at Bula; at the State Line about — miles north of Glover, West Virginia, where a 16 inch line of the Hope Company delivers into a 16 inch line of the Peoples Company and gas is measured by Pitot tubes at Glover; Eldersville Station, where a 6 inch line of the Hope Company delivers into a 6 inch line of the Peoples Company and the gas is measured by meter; Eddy Station, where a 3 inch line of the Hope Company delivers into a 16 inch line of the Peoples Company and the gas is measured by meter; and Fordyce Station, where a 6 inch line of the Hope Company delivers into a 16 inch line of the Peoples Company and the gas is measured by meter. The Managers of the parties hereto shall from time to time agree upon the proportion of such gas to be delivered at each of said stations; in case of the failure of the Managers so to agree, the Hope Company shall
64 deliver the gas at each station in the proportions designated by the Peoples Company in so far as it can make such deliveries from its current sources of supply without additional investment in pipe lines or transportation facilities.

Eighth. The gas deliverable hereunder shall be measured at the location of the present Pitot tube and meter measuring stations or at such other locations as may hereafter be agreed upon as near the points of delivery of the gas as such locations may be secured.

The Pitot tube stations at Glover and at Bula, near the State line between the States of Pennsylvania and West Virginia, are hereby adopted as permanent delivery stations where the gas deliverable hereunder shall be measured by Pitot tubes of standard registering type, or by any other measuring devices which may be substituted by subsequent agreement of the parties. The expense of erecting, maintaining and operating all stations from time to time shall be borne equally by the parties hereto and the stations shall be under their joint control, with the right to each company to keep an employe or employes there for the purpose of checking the gas measurements. The measuring tubes in the Pitot tube stations shall
65 be read at 15 minute intervals throughout each day of 24 hours, and duplicate statements of the daily readings shall be mailed daily to each party; when meters are used the Hope Company shall read the meters daily or as often as the meters require but each party shall have constant access to the meters. The amount of gas delivered and so measured shall be computed upon said readings on a basis of 10 ounces to the square inch above 14.4 pounds atmospheric pressure, according to Boyle's law for the measurement of gas at varying pressures, without correction for temperature or barometric conditions, and such computations shall be and are hereby adopted as the basis of measurements and payments for the gas delivered hereunder.

Ninth. If either party challenges the accuracy of any meter in use under this contract and desires to have the meter tested or repaired, the Peoples Company shall test and repair the same in the presence and to the satisfaction of the Hope Company or a representative, if the Hope Company wishes to exercise the right
66 to be present or to be represented at such test; the cost of testing and repairing the meter shall be borne by the party challenging the accuracy of the same, if the meter on test proves to be correct, or within 3 per cent. correct; but if the meter on test proves more than 3 per cent. fast or slow, then the cost of testing and repairing the meter shall be borne equally; for repair work the meter shall be shipped to Pittsburgh, Pennsylvania, or to any properly equipped shop of the Peoples Company, and there tested, adjusted or repaired. During such time as the meter or meters are out of repair and while being tested, the gas taken shall be estimated until the repaired meter is installed, and adjustment and settlement shall be made at the regular monthly periods on the basis of the amount of gas registered at like pressures for like periods of time when the meter was registering accurately. The statements of meter measurements and estimated adjustments, which under this contract are to be rendered by the Hope Company to the Peoples Company at the end of each month, shall be conclusive on the parties hereto, unless exceptions thereto in writing shall be
67 made by the Peoples Company and mailed to the Hope Company within four days after the Peoples Company shall receive the statements.

Tenth. The Peoples Company undertakes and agrees that on or

before the 15th day of each month, it will furnish to the Hope Company a statement of the amount of gas registered by the meters of consumers paying domestic rates during the preceding month, which statement shall show as nearly as practicable the amount of gas delivered by the Peoples Company, and other companies to which it may supply gas, to consumers paying domestic rates; the said statement shall also include the amount of gas delivered by the Peoples Company, and by companies supplied by it with gas, during the preceding month, to consumers for manufacturing and other special purposes, and the rates and prices at which all gas is sold. The Peoples Company shall also add such other data as the Hope Company may reasonably require, or as may be necessary to enable the Hope Company to determine the amount of money which it is entitled to receive for gas supplied by the Hope Company to the Peoples Company. The Hope Company undertakes and
68 agrees that on or before the 25th day of the month it will furnish to the Peoples Company a detailed statement of the amount of gas delivered by it during the preceding month as measured by the Pitot tube and meter stations at the State line where gas is deliverable hereunder.

Eleventh. The Peoples Company undertakes and agrees that it will pay in semi-monthly installments the amount due to the Hope Company for all gas delivered by the Hope Company to the Peoples Company during the preceding month; the first installment shall be 75 per cent of the total amount due for the month and shall be approximated by the Hope Company upon the basis of the measurements at the points of delivery at the State line; the second installment or balance shall be paid in full on the 30th day of the month.

Twelfth: It is understood and agreed that the Hope Company is obligated to deliver gas hereunder at the points and in the amounts stipulated for herein, and that the Hope Company will use all reasonable diligence in developing and extending its gas leases
69 and properties in the State of West Virginia and in obtaining gas therefrom for the purpose of fulfilling its obligations hereunder, and that it will use all reasonable diligence to drill wells and to construct the necessary pipe lines and to maintain its pipe lines and wells in good order and condition to supply the gas which it has herein undertaken to deliver, but that it is not obligated to compress and pump the gas unless it so desires or unless it becomes necessary so to do to maintain the deliveries at a pressure at the delivery points hereunder of not less than 10 pounds to the square inch; the Peoples Company is required to provide such pipe line capacity and such gas compressing and pumping stations as may be necessary to take from the Hope Company at said pressure of 10 pounds to the square inch and to transport to its markets the current amounts of gas purchased and to be taken hereunder.

Thirteenth. The Peoples Company undertakes and agrees that it will not deliver gas to consumers and the companies which it supplies will not deliver gas to consumers at a pressure exceeding 8 ounces above atmospheric pressure.

Fourteenth. It is mutually understood and agreed that where either party to this contract fails to perform any obligation
70 herein assumed by it, and such failure is due to Acts of God, or a public enemy, strikes, riots, injunctions or other interferences through legal proceedings, breakage or accident to machinery or lines of pipe, washouts, earth-quakes, storms, freezing of lines or wells, sudden or unforseen failure of gas wells, or to any cause not due to the fault or neglect of such party, or is caused by the necessity for making repairs or alterations in machinery or lines of pipe, such failure shall not be deemed to be a violation by such party of its obligation hereunder, but such party shall use due diligence to again put itself in position to carry out all of the obligations, which by the terms hereof, it has assumed.

Fifteenth. The Peoples Company further undertakes and agrees that the Hope Company shall at all times through its properly authorized representatives have the right to examine the books of account of the Peoples Company and of each of the companies to which the Peoples Company supplies gas, so far as said books of account in any way relate to the purchase or distribution of gas.

71 Sixteenth. It is mutually understood and agreed that for the purposes of this contract the terms "Manufacturing Gas" and "Gas sold for manufacturing purposes" and "Gas sold for manufacturing and other special purposes" shall be deemed to include all gas sold to consumers other than to consumers paying domestic rates.

Seventeenth. Any gas that may be used by the Peoples Company for the operation of compressing stations or other plants owned by it, or for lighting or heating its own compressing or pump station buildings, shall be deemed to be gas sold for manufacturing purposes, at the prevailing manufacturing rates, excepting that the rate shall at no time exceed 15 cents per thousand cubic feet.

72 Eighteenth. No dominion or control over the natural gas delivered under this contract shall remain in the Hope Company after the gas passes the points of delivery above stated, nor shall the Hope Company be responsible for or on account of anything that may thereafter be done, happen or arise touching said gas; the Peoples Company undertakes and agrees that it will at all times and from time to time keep free, save harmless and indemnify the Hope Company from any and all manner of claims, suits and damages on account of any conduct, act or thing touching said gas after it has left the said points of delivery; and the Hope Company undertakes and agrees that it will to the same extent and in like manner indemnify the Peoples Company from any conduct, act or thing touching said gas up to said points of delivery.

Nineteenth. In case of the acquisition at any time hereafter by the Peoples Company of additional distributing systems requiring an additional supply for consumers paying domestic rates, the
73 amount of gas requisite for the supply of consumers paying domestic rates on such systems, shall at the option of the Hope Company, be added to the amount of gas to be purchased and taken

hereunder, provided, however, that the Hope Company shall, in case of any such situation, exercise such option within 60 days after written notice from the Peoples Company requiring it so to do.

Twentieth. It is mutually understood and agreed that in case the Peoples Company makes fraudulent representations as to the amount of gas delivered by it or by the companies supplied with gas by it, or shall fail to render the statements herein required of it, or shall fail to perform the covenants in which it is hereby bound, or shall fail to pay to the Hope Company any amounts that may be due and payable hereunder to the Hope Company within 20 days after such amount becomes due and payable, the Hope Company shall have the right, without cancelling this contract or waiving any of its rights hereunder, to suspend the delivery of natural gas hereunder,
74 until all amounts due to it are paid, or at its option shall have the right to terminate this contract on 30 days' notice to the Peoples Company without prejudice to its right to collect the amounts due to it at the time of such termination for natural gas previously furnished hereunder.

Twenty-first. This contract shall continue, unless previously terminated by mutual consent of the parties hereto, so long as the Hope Company produces gas in marketable quantities from the gas fields leased or owned by it in West Virginia, but the Hope Company reserves the right to sell and deliver gas to other persons, firms and corporations engaged in the business of distributing natural gas, and in the ordinary course of its business to sell and dispose of the gas properties now or hereafter owned or leased by it; but it is understood and agreed that the Hope Company is obligated to deliver gas for consumers of the Peoples Company paying domestic rates and for consumers paying domestic rates of companies supplied with gas by the Peoples Company including the ordinary growth and
75 accretions of the Peoples Company and companies supplied with gas by it in the territory mentioned in the recitals of this contract, in preference to all other consumers, or persons, firms and corporations distributing gas under contracts with the Hope Company, excepting only the domestic consumers on the lines of the Hope Company in West Virginia, and the domestic consumers on distributing systems owned or controlled by The East Ohio Gas Company, which are being supplied under a contract between The East Ohio Gas Company and the Hope Company; in case at any time during the continuance of this contract the natural gas produced from the gas fields then owned and leased by the Hope Company is not sufficient to fulfill the requirements of the consumers paying domestic rates upon the distributing systems supplied by the Peoples Company, together with the requirements of the domestic consumers upon the distributing systems owned or supplied by The East Ohio Gas Company, then the Peoples Company shall not be entitled to require the Hope Company to supply to it under this contract a greater proportion of the national gas produced by the Hope Company from the properties then owned or leased by it, or purchased by the
76 Hope Company from other producers, than the number of consumers paying domestic rates supplied by the Peoples

Company bears to the total number of domestic consumers on the distributing systems owned or supplied by The East Ohio Gas Company and the consumers paying domestic rates on distributing systems owned or supplied by the Peoples Company, and that the domestic consumers of the Hope Company in West Virginia may at all times be supplied in full by the Hope Company, so that for the purposes of this contract the gas produced by the Hope Company will be the total amount produced by it after deducting the amount requisite for the supply of its domestic consumers in West Virginia.

Twenty-second. There is excepted out of the operation and effect of this contract that certain contract made by the Peoples Company to sell and deliver a fixed quantity of gas to the United Natural Gas Company at the junction of the lines of the two companies in Clarion County, Pennsylvania, which contract bears date the 6th day of June, 1907; the United Natural Gas Company, to the
77 extent of the gas that it is purchasing from the Peoples Company under said excepted contract, shall not be considered as a company supplied with gas by the Peoples Company within the provisions of this contract.

Twenty-third. This contract shall be binding upon the parties hereto and their successors and assigns, respectively, provided, however, that in case the gas distributing system now or hereafter owned or controlled by the Peoples Company is broken up, so that parts thereof are vested in different owners, the Hope Company at its option shall have the right to terminate this contract.

78 In witness whereof the parties hereto have caused their corporate names to be signed by their respective presidents or Vice Presidents, and their respective seals to be hereunto affixed by their respective Secretaries the day and year first above written.

HOPE NATURAL GAS COMPANY,
By JOHN TONKIN,
Vice President.

Attest:

[Corporate Seal.]

CHRISTY PAYNE,
Secretary.

THE PEOPLES NATURAL GAS COMPANY,
By JOHN G. PEW,
Vice President.

Attest:

[Corporate Seal.]

CHRISTY PAYNE,
Secretary.

Exhibit C. Board of Directors, June 29th, 1911. Christy Payne, Secretary.

79 [Endorsed:] Copy. Misc. #2525. Gas purchase agreement, Hope Natural Gas Company to sell to The Peoples Natural Gas Company. Dated —— —, 1911.

79a PENNSYLVANIA EXHIBIT 18.

Offered at p. 225 of Printed Record by Witness Sullivan.

Contract Between the Reserve Natural Gas Company, Union Natural Gas Company, Hope Natural Gas Company, Connecting Gas Company, and T. N. Barnsdall, Dated April 11, 1913.

80 Reserve Gas Company, party of the first part.
Union Natural Gas Corporation, party of the second part.
Hope Natural Gas Company, party of the third part.
The Connecting Gas Company, party of the fourth part.
T. N. Barnsdall, party of the fifth part.

81 This agreement, Made and entered into this 11th day of April A. D. 1913, by and between Reserve Gas Company, a West Virginia corporation, hereinafter called "Reserve," party of the first part; Union Natural Gas Corporation, a Delaware corporation, hereinafter called "Union," party of the second part; Hope Natural Gas Company, a West Virginia corporation, hereinafter called "Hope," party of the third part; The Connecting Gas Company, an Ohio corporation, hereinafter called "Connecting," party of the fourth part; and T. N. Barnsdall, of Pittsburgh, Pennsylvania, party of the fifth part:

Whereas, said T. N. Barnsdall, Hope and Reserve entered into two written agreements, each bearing date the 20th day of June, 1902, for the production, transportation and sale of natural gas, and the rights and interests of said T. N. Barnsdall in the said two agreements were subsequently sold and assigned by him to Union; and

Whereas, the above named agreements have been modified from time to time by supplementary contracts between the parties hereto; and

81½ Whereas, it is deemed advisable that a new agreement be made and entered into between the parties hereto, and that the contracts above referred to, and certain existing contracts hereinafter enumerated be cancelled and annulled; and

Whereas, Reserve owns the gas rights or leasehold gas rights in about 55,600 acres of land in Harrison and Lewis Counties, West Virginia, together with 352 producing gas wells thereon, field lines and a compressing station; also two gas transportation trunk lines, each 12 inches in diameter, extending from the field in a northwesterly direction to Schultz, Pleasants County, West Virginia; also two trunk lines 16 inches in diameter, extending in a northwesterly direction from Schultz, West Virginia, to the south-east bank of the Ohio River; also three 10 inch pipe lines crossing the river to its northwest bank, which river crossings are about to be increased by the construction of three additional 10 inch pipe lines, all ending at a point known as Gravel Bank on the Ohio state line, and

Whereas, Connecting owns two gas transportation trunk lines each 16 inches in diameter, connected to the said river crossing lines of Reserve Gas Company at Gravel Bank on the northwest
82 shore of the Ohio River, and extending in a northwesterly direction, passing near Chesterhill, Ohio, and Jacksonville, Ohio to Sugar Grove, and

Whereas, Hope and Union have heretofore been buying from Reserve natural gas which has been transported by Reserve through its pipe lines in the State of West Virginia to the junction with the lines of Connecting at Gravel Bank on the Ohio State line, and by Connecting through its lines in Ohio for delivery to Union or parties designated by it at Jacksonville and Sugar Grove, and to Hope or parties designated by it at or near Gravel Bank, Chesterhill and Sugar Grove:

Now, therefore, this agreement witnesseth: That the parties hereto, for and in consideration of the sum of One Dollar to each of the others in hand paid by each of the parties hereto, at and before the sealing and delivery hereof, the receipt of which is hereby acknowledged, and of the covenants and agreements hereinafter con-
83 tained by each of the parties hereto to be well and truly kept and performed, have covenanted and agreed, and by these presents do covenant and agree:

1. Each of the following contracts is hereby terminated and cancelled to take effect on April 11th, 1913 on which day it is understood and agreed that the cancellation thereof shall be duly noted upon the original contract in each case, namely:

Agreement dated the 20th day of June, 1902, wherein T. N. Barnsdall is party of the first part, Hope Natural Gas Company party of the second part, and Reserve Gas Company party of the third part.

Agreement dated the 20th day of June, 1902, in which Reserve Gas Company is party of the first part, T. N. Barnsdall, party of the second part, and Hope Natural Gas Company party of the third part.

Agreement dated the 31st day of March, 1904, wherein Reserve Gas Company is party of the first part, Union Natural Gas Corporation party of the second part, and Hope Natural Gas Company party of the third part.

Two agreements each bearing date the 2nd day of February, 1905, in which Reserve Gas Company is party of the first part, Union Natural Gas Corporation party of the second part, and Hope Natural Gas Company party of the third part.

Agreement dated January 30th, 1907, in which Reserve Gas Company is party of the first part, Union Natural Gas Corporation party of the second part, Hope Natural Gas Company party of the third part, and The Connecting Gas Company party of the fourth part.

Agreement dated September 3, 1907, in which Reserve Gas Company is party of the first part, Union Natural Gas Corporation, party of the second part, and Hope Natural Gas Company, party of the third part.

Agreement dated the 24th day of October, 1908, in which Union Natural Gas Corporation is party of the first part, and Reserve Gas Company party of the second part.

84 Agreement dated November 29, 1912, in which Reserve Gas Company is party of the first part, Union Natural Gas Corporation party of the second part, Hope Natural Gas Company party of the third part, and The Connecting Gas Company party of the fourth part.

It is mutually understood and agreed that the only contracts, agreements or understandings between the parties hereto, or any of them, to which Hope, Reserve and Connecting is a party, which are not cancelled and superseded hereby are those enumerated in Schedule "A" hereto annexed.

2. Whenever in accordance with the provisions of this contract a stated amount of gas is to be taken in any one year, or gas is to be taken at a specified rate per annum, a proportion of such yearly amount shall be taken in each month of such year according to the following table of percentages, in which the said proportion to be taken in each month is specified, viz:

May	7½%
June	4¾
July	4½
August	4½
September	4¾
October	7½
November	10½
December	12
January	12½
February	12
March	11
April	8½

3. Between the date hereof and the first day of November, 1913, Union shall purchase and take from Reserve natural gas at the rate of 9,260,000,000 cubic feet for the year; during said period

85 Hope shall purchase and take from Reserve all the natural gas necessary to enable Hope to supply the requirements of The Northwestern Ohio Natural Gas Company under the existing contract between Hope and said company, or any other contract that may hereafter be made by Hope to supply said Company. Hope shall also have the option of purchasing and taking from Reserve between the date hereof and November 1st, 1913, an amount of natural gas not exceeding an amount which added to the amount taken by it to supply the requirements of The Northwestern Ohio Natural Gas Company and the requirements of its customers at Chesterhill and Gravel Bank shall equal the amount taken by Union from Reserve during the same period, but the total amount which Hope shall be entitled to take on any one day at Sugar Grove, Chesterhill and Gravel Bank shall not aggregate more than thirty million cubic feet.

4. During the year commencing November 1st, 1913, and expiring October 31st, 1914, and during each and every subsequent year of the continuance of this contract, Hope and Union respectively shall purchase and take from Reserve, and Reserve shall sell and deliver natural gas in the following amounts:

Union shall purchase and take and Reserve shall sell and deliver to it ten billion cubic feet and such additional amount as shall be specified in the notice hereinafter provided for.

86 During each year until the year commencing November 1st, 1917, Hope shall purchase and take and reserve shall sell and deliver to it ten billion cubic feet and such additional amount as shall be specified in the notice hereinafter provided for, and during the year commencing November 1st, 1917, and each subsequent year fifteen billion cubic feet and such additional amount as shall be specified in the notice hereinafter provided for.

But the obligations of Reserve hereunder to sell and deliver gas are limited to the amount which it has available for delivery as defined in the 8th paragraph of this agreement, and shall not in the case of Union exceed twelve billion cubic feet in any one year, and shall not in the case of Hope exceed eighteen billion cubic feet in any one year.

5. On or before the 1st day of May, 1913, and on or before the 1st day of May in each subsequent year, Union and Hope shall each give written notice to Reserve specifying the amount of gas which it will require hereunder in the year commencing November 1st following such yearly notice.

6. The amount to be taken during any year shall be taken during the different months thereof according to the tables of percentages hereinbefore set forth, and the amount to be taken each month shall be taken throughout the month in approximately equal daily amounts provided, however, that Union and Hope shall each have the right to reduce or increase the amount to be taken by it

87 during any month so long as the amount taken is between 90% and 110% of the amount deliverable during such month, determined as above, and shall have the right to increase or reduce the amount of gas to be taken on any day of the month so long as the amount taken in each day is between 80% and 120% of the amount deliverable during such day determined as above. It is understood, however, that each of said companies must purchase and take during the six summer months beginning May 1st, in each year at least one half as much gas as it took during the preceding six winter months, even though in the case of Union the amount which it is thereby required to take during the year is made to exceed twelve billion cubic feet, and in the case of Hope the amount which it is thereby required to take during the year is made to exceed eighteen billion cubic feet.

7. The gas to be taken by Union shall be delivered at Sugar Grove and Jacksonville through the lines of Connecting to Union or to any company or companies designated by Union; the gas to be taken by

Hope shall in part be delivered to it through the lines of Connecting at the following places: (*a*) at Sugar Grove for the purpose of fulfilling the requirements of The Northwestern Ohio Natural Gas Company under the contract now existing, or any contract that may hereafter be made by Hope to supply said company, or any other company at that point; (*b*) at Chesterhill for the requirements of The River Gas Company in supplying Chesterhill and the village of Stockport; and (*c*) at Gravel Bank for the requirements of local consumers; but the amount of gas to be delivered to Hope
88 through the lines of Connecting at the three delivery points above named, shall not exceed the maximum of thirty million cubic feet in any one day of 24 hours. The balance of the amount of gas to be taken by Hope shall be delivered to it (*d*) at a central point or points in Reserve's gas field; (*c*) at the delivery end of the new line or lines to be constructed by Reserve and Connecting, or by Reserve alone, upon the demand of Hope as hereinafter provided.

8. Reserve will use reasonable diligence in developing and drilling upon its gas leases and properties for the purpose of obtaining the gas necessary to fulfill its obligations hereunder, and for the above purpose will build, maintain and provide in good order, condition and manner the necessary compressor stations and gathering lines connecting its wells with the same, and also will use reasonable diligence in obtaining and developing new gas leases and new contracts for gas when the same become necessary and available in order to enable it to deliver gas under the terms of this contract, but nothing herein contained shall obligate Reserve to extend, develop or drill gas leases or to construct compressor stations or pipe lines, or to keep in force existing leases except so far as it is reasonably profitable for it so to do. Whenever Reserve, although it is duly per-
89 forming its obligations in this paragraph contained, has not available for delivery the full amount of gas to which Union and Hope are entitled under the provisions hereof, Union and Hope shall be entitled to require Reserve to deliver only the amount which it has available for delivery, and Hope shall be entitled to require that 3/5 of the total amount which Reserve has remaining available for delivery from all sources shall be delivered to it, and Union shall have the right to require the delivery to it of 2/5 of said amount. This contract shall continue until Reserve no longer has available for delivery gas in marketable quantities sufficient to enable it to continue in business without loss.

9. Reserve will construct one additional sixteen inch pipe line from its field to Schultz, Provided, that Union serves written demand upon it a sufficient time prior to November 1st, 1915, to enable it, by the exercise of reasonable diligence, to complete the construction of said line on or before that date.

Hope shall have the right at any time to require Reserve, or Reserve and Connecting, to construct an additional line or additional lines extending from the field of Reserve to such point or points, and having such capacity, as Hope may designate, Provided, that

the capacity of said line or lines shall not exceed the amount
90 by which the daily capacity of the lines from the field of Reserve to Sugar Grove then existing, exceeds fifty million cubic feet, and Provided, that the cost thereof shall not exceed the cost of then constructing a line from the field of Reserve to Sugar Grove having a capacity equal to the amount by which the daily capacity of the lines from the field of Reserve to Sugar Grove then existing exceeds fifty million cubic feet per day. If any such additional line is constructed to Gravel Bank, Chesterhill or Sugar Grove, the provisions of the 7th paragraph and the 3rd paragraph hereof, limiting the amount of the daily deliveries to Hope at those points to thirty million cubic feet, shall have no application to any amount delivered to it through such additional pipe line.

In case Hope shall serve written notice upon Reserve or upon Reserve and Connecting, requiring it or them to construct any such pipe line, Reserve in the one case, and Reserve and Connecting in the other, will with all due diligence comply with the said demand, it being understood that any line built in West Virginia shall be built by the Reserve and any line built in Ohio shall be built by the Connecting.

10. In case either Reserve or Connecting in order to carry out its obligations hereunder, requires to obtain money by borrowing the same, or by increasing its capital stock or otherwise, Union
91 will subscribe for and take one half of the stock, bonds or evidences of indebtedness issued for the purpose of obtaining such money, and Hope will subscribe for and take the other half of such stocks, bonds or evidences of indebtedness.

11. The price per thousand cubic feet for gas sold by Reserve to Hope and Union shall be as follows:

Delivered in the year.	In the field	At Sugar Grove, Jacksonville, Chesterhill, Gravel Bank, or delivery end of line that may be constructed on demand of Hope as hereinbefore provided.
1913	4½ cents.	8½ cents.
1914	5 "	9 "
1915	5½ "	9½ "
1916	6 "	10 "
1917	6½ "	10½ "
1918	7 "	11 "
1919	7½ "	11½ "
1920	8 "	12 "
1921	8½ "	12½ "
1922	9 "	13 "
1923	9½ "	13½ "
1924	10 "	14 "

and for the period beyond the year 1924 to remain at the price last above named.

It is understood and agreed that all of the prices above enumerated are based upon a delivery of the gas by Reserve after the gas has been compressed by it in its compressor stations.

12. Connecting agrees to receive, transport and deliver all the gas which in accordance with the provisions hereof is to be delivered through the lines of Connecting; such gas shall be transported
92 for the same charge, viz: 2¼ cents per thousand cubic feet, and, excepting as hereinafter provided, upon the same terms and conditions as are specified in the written contract dated March 31st, 1904, between Reserve and Connecting, under and by virtue of which gas is at present being transported through the lines of Connecting; the said charge of 2¼ cents per thousand cubic feet shall be paid by Reserve monthly on or before the 25th day of the month following that in which the gas was transported.

13. Connecting agrees to maintain at its own cost and expense and operate its Pitot tube measuring station at Sugar Grove, and to erect and maintain at its own cost and expense recording Pitot tube or orifice meter measuring devices for the accurate measurement of all gas to be delivered out of its lines at Jacksonville, Chesterhill and Gravel Bank; and Connecting further agrees to keep its lines, connections and the measuring stations at all times in a condition of good repair to prevent any loss of gas in its transmission and measurement and to accurately account for the gas carried and delivered by it.

14. Reserve will at its own expense erect and maintain in good order and repair and operate all such Pitot tube measuring stations or recording orifice meters as may be necessary to accurately measure all gas delivered to Hope in the field; and at the terminal
93 of the line or lines to be constructed upon the demand of Hope, a similar station or meter, or stations or meters, will be erected, maintained and operated by Reserve, if Reserve constructs and owns the enti-e line, or by Connecting if the terminal of said line is constructed, owned and operated by Connecting.

15. The gas to be sold and delivered under this agreement and measured as aforesaid, shall be computed upon a basis of a pressure of 10 ounces to the square inch above 14.4 pounds atmospheric pressure according to Boyle's Law for the measurement of gas at varying pressures, without correction for temperature or barometric conditions.

16. If either party to this contract fails to perform any obligations herein assumed by it, and such failure is due to Acts of God, or to a public enemy, strikes, riots, injunctions or other interferences through legal proceedings, breakage or accident to machinery or lines of pipe, washouts, earthquakes, storms, freezing of lines or wells, sudden partial or entire failure of gas wells, or any cause beyond its control, or is caused by the necessity of making repairs or alterations in machinery or lines of pipe, such failure shall not be deemed to be a violation by such party of its obligations hereunder;

but such party shall use due diligence to again put itself
94 in position to carry out all of the obligations which by the terms hereof it has assumed.

17. Connecting shall furnish to Reserve on or before the 8th day of each month, and Reserve shall furnish to Hope and Union on or before the 10th day of each month, a statement showing the amount of gas delivered to it during the preceding month, and Hope shall pay for the gas delivered to it, and Union shall pay for the gas delivered to Union, on or before the 25th day of the month in which such statement is furnished. If either party shall be in default in any payment for the period of 15 days, Reserve shall have the right without cancelling this contract or waiving any of its rights hereunder, or prejudicing the rights of any other party, to suspend the delivery of gas hereunder to the party in default, and to require Connecting to shut off such supply of gas from such party in default until all amounts due to Reserve are paid with interest at 6 per cent from the time such amounts are due.

18. Union and Hope shall each have the right at any reasonable time or times by duly designated agents to examine the books of accounts of Reserve and of Connecting, and all records relating
95 to the delivery of gas by either of said companies, and the measurement of gas so delivered, and to inspect and test any and all pipes, stations, appliances and measuring devices used by Reserve and Connecting.

In witness whereof the corporations parties hereto have hereunto caused their corporate seals to be affixed and the same to be attested by their respective Presidents or Vice Presidents and Secretaries, and the said T. N. Barnsdall has hereunto set his hand and seal the day and year first above written.

RESERVE GAS COMPANY, [Corporate Seal.]
By E. P. WHITCOMB,
Vice President.

Attest:
CHRISTY PAYNE,
Secretary.

HOPE NATURAL GAS COMPANY,
By JOHN G. PEW, [Corporate Seal.]
Vice President.

Attest:
CHRISTY PAYNE,
Secretary.

UNION NATURAL GAS CORPORATION,
By E. P. WHITCOMB,
Vice President.

Attest:
[Corporate Seal.]
W. R. HADLEY,
Secretary.

FOLDOUT(S) IS/ARE TOO LARGE TO BE FILMED

THE CONNECTING GAS COMPANY,
By JOHN G. PEW, [Corporate Seal.]
President.

Attest:
CHRISTY PAYNE,
Secretary.

T. N. BARNSDALL. [SEAL.]

Witness:
——, ——.

(Here follows Schedule A, marked pages 96-99, inclusive.)

100 [Endorsed:] Copy. Miscellaneous Files. 2344. Agreement, Reserve Gas Company, Union Natural Gas Corporation, Hope Natural Gas Company, The Connecting Gas Company, and T. N. Barnsdall, in re gas supply, deliveries, etc. Dated April 11", 1913.

100*a* PENNSYLVANIA EXHIBIT 19.

Offered at p. 225 of Printed Record by Witness Sullivan.

Contract Between the Hope Natural Gas Company and the East Ohio Gas Company Dated March 1, 1910.

101 Gas Purchase Agreement, Hope Natural Gas Company & The East Ohio Gas Company.

March 1, 1910.

102 This agreement, made and entered into this 1st day of March, A. D. 1910, by and between the Hope Natural Gas Company, a West Virginia corporation, hereinafter called the "Hope Company," party of the first part, and the East Ohio Gas Company, an Ohio corporation, hereinafter called the "Ohio Company," party of the second part.

Witnesseth: Whereas, the Hope Company is the owner of natural gas wells, gas rights and leases for gas purposes in the State of West Virginia, and is the owner of pipe lines extending from its natural gas territory in the State of West Virginia to the boundary of the State of Ohio on the Ohio River; and

Whereas, the Ohio Company holds franchises and distributing systems for the distribution of natural gas in the City of Cleveland and other cities, villages and towns in the State of Ohio, and is the owner of three trunk lines extending from the boundary of the State of Ohio on the Ohio River, through the State of Ohio to the City of Cleveland, and connecting with distributing systems owned by the said Ohio Company in the City of Cleveland, and in various cities, villages and towns in the State of Ohio;

Now, Therefore, in consideration of the premises and of the mutual covenants and agreements herein contained, the parties hereto have agreed and do hereby agree as follows:

First. It is mutually understood and agreed that all the rights of the parties hereto in respect to natural gas sold and delivered by the Hope Company to the Ohio Company on and after March 1st, 1910, shall be ascertained and determined by and in accordance with the provisions of this agreement.

Second. The Hope Company undertakes and agrees during the continuance of this contract to sell and deliver to the Ohio Company and the Ohio Company undertakes and agrees to purchase and take from the Hope Company,—

(*a*) All the natural gas requisite for the supply of the domestic consumers of the Ohio Company;

103 (*b*) Such amounts of natural gas as may be requisite to fulfill contracts made with the consent and approval of the Hope Company by the Ohio Company, or companies which it supplies with natural gas, for the sale of gas upon special terms and conditions for manufacturing purposes;

provided, however, that the Hope Company shall not be obligated to sell and deliver or the Ohio Company to purchase and take gas in excess of the amounts currently required for the purposes aforesaid, or in excess of the amount which can be transported through the trunk lines of the Ohio Company as at present constructed under a pressure of 225 pounds at the Ohio River and that the Hope Company cannot be required to deliver gas in excess of the amount which it has available for delivery as defined in the Seventh Paragraph hereof.

The Ohio Company further undertakes and agrees that if at any time its requirements of natural gas for the purposes aforesaid exceed the amount which can be transported through its trunk lines from the Ohio River as at present constructed, it will purchase such excess from the Hope Company on the terms herein stated to the extent that the Hope Company is willing and able to furnish the same, and the trunk lines of the Ohio Company from the Ohio River are then sufficient to transport the same, provided, however, that if at any time the Ohio Company shall give written notice to the Hope Company of its intention to increase by new construction the then existing capacity of its pipe lines from the Ohio River within one year from the date of such notice by an amount designated in such notice and does so increase its pipe line capacity within such year, the Hope Company shall not be entitled to require the Ohio Company to purchase and take natural gas hereunder in excess of the capacity of the trunk lines from the Ohio River as they existed prior to such increase under a maximum pressure of 225 pounds at the Ohio River, unless within sixty days after the receipt of such written notes, it serves on the Ohio Company written notice that for the purposes of this agreement the capacity of the trunk lines from the Ohio River as increased by such additional construction under a maximum pressure of 225 pounds at the Ohio River shall be substituted for the existing capacity of said trunk lines.

104 Third. It is mutually understood and agreed that the natural gas to be sold and delivered hereunder shall be delivered by the Hope Company to the Ohio Company at the boundary line between the State of Ohio and the State of West Virginia at the points where the lines of the Hope Company now connect with the trunk lines of the Ohio Company, or at such other points as may be mutually agreed upon between the parties hereto.

Fourth. It is further mutually understood and agreed that no dominion or control over the natural gas delivered under this contract shall remain in the Hope Company after the gas passes the points of

delivery above stated, nor shall the Hope Company be responsible for or on account of anything that may thereafter be done, happen or arise touching said gas, and the Ohio Company undertakes and agrees that it will at all times and from time to time keep free, save harmless and indemnify the Hope Company from any and all manner of claims, suits and damages on account of any contract, act or thing touching the said gas after it has left the said point of delivery.

Fifth. The Hope Company undertakes and agrees subject to the provisions of Paragraph Seventh hereof that at all times during the continuance of this contract it will maintain in good order and condition all its compressing stations, pipe lines, connections and other facilities in the State of West Virginia in order to enable it to carry out its obligations under this contract, and to deliver gas hereunder in such volume as to maintain a pressure equivalent to 225 pounds at the junction point of its lines with the lines of the Ohio Company as at present constructed and operated at the Ohio River; and will use due and reasonable diligence in developing its gas leases and properties in the State of West Virginia and in obtaining gas therefrom for the purpose of fulfilling its obligations hereunder, and will, if and when required so to do by the Ohio Company, deliver the gas to be supplied by it hereunder at a pressure equivalent to 225 pounds at the Ohio River end of the trunk lines of the Ohio Company as at present constructed.

105 Sixth. It is mutually understood and agreed that where either party to this contract fails to perform any obligation herein assumed by it, and such failure is due to Acts of God, or a public enemy, strikes, riots, injunctions, or other interferences through legal proceedings, breakage or accident to machinery or lines of pipe, washouts, earthquakes, storms, freezing of lines, or wells, sudden or unforseen failure of gas wells, or to any cause not due to the fault or neglect of such party, or is caused by the necessity for making repairs or alterations in machinery or lines of pipe, such failure shall not be deemed to be a violation by such party of its obligations hereunder, but such party shall use due diligence to again put itself in position to carry out all of the obligations which by the terms hereof, it has assumed.

Seventh. It is further understood and agreed between the parties hereto that this contract shall continue, unless previously terminated by mutual consent of the parties hereto, so long as the Hope Company produces gas in marketable quantities from the gas fields owned or leased by it in West Virginia, but that the Hope Company reserves the right to make and enter into contracts with other companies for the sale to such companies of natural gas and in the ordinary course of its business to sell and dispose of the gas properties now or hereafter owned or leased by it; but it is understood and agreed that the Hope Company is obligated to deliver gas for domestic consumers of the Ohio Company in preference to all other consumers, or persons, firms and corporations distributing gas under contracts with the Hope Company, excepting only the domestic consumers on the lines of the Hope Company in West Virginia, and the consumers

paying domestic rates upon the distributing systems owned or supplied with gas by the Peoples Natural Gas Company which is now obtaining gas from the Hope Company, and that in case at any time during the continuance of this contract the natural gas produced in the gas fields then owned and leased by the Hope Company is not sufficient to fill the requirements of domestic consumers on distributing systems which at such time are purchasing natural gas from the Hope Company, the Ohio Company shall not be entitled to
106 require the Hope Company to supply to it under this contract a greater amount of natural gas than the proportion of the natural gas produced by the Hope Company from the properties then owned or leased by it, which the number of domestic consumers supplied by the Ohio Company bears to the total number of domestic consumers on the distributing systems owned or supplied by the Ohio Company and the consumers paying domestic rates on distributing systems owned or supplied with gas by the Peoples Natural Gas Company, and that the domestic consumers of the Hope Company in West Virginia may at all times be supplied in full by the Hope Company, so that, for the purposes of this contract, the gas produced by the Hope Company will be the total amount produced by it after deducting the amount requisite for the supply of its domestic consumers in West Virginia.

Eighth. It is mutually understood and agreed that the Ohio Company shall keep the Hope Company at all times fully informed of all facts tending to show the amount of natural gas which will be necessary from time to time to supply its requirements hereunder, and that so long as the Hope Company exercises due diligence in making provision to supply or does supply the amount of natural gas estimated to be necessary to meet such requirements, it shall not be liable by reason of its failure to supply gas in excess of said estimated amount.

Ninth. The Ohio Company undertakes and agrees at all times during the continuance of this contract that the trunk lines from the Ohio River to the City of Cleveland and all branches therefrom and the various distributing systems connected therewith will be kept in good order and condition, so as to reduce, as far as possible, the waste and escape of gas, and that all gas supplied by it to domestic consumers or for manufacturing purposes shall be measured by standard meters which it will install and keep in good order and condition, and that all gas supplied to consumers by companies to which it sells gas shall be measured by similar meters, which, together with all other pipe and appliances of such companies, the Ohio Company agrees shall be kept in good order and repair; that all of said meters used for measuring gas sold for domestice purposes shall be
107 read at least once in each calendar month and that meters used for measuring gas sold for manufacturing purposes pursuant to the provisions hereof, shall be read daily and that reports of the readings of all meters shall be furnished monthly to the Hope Company. The amount of gas sold for lighting streets where measurement by meter is impracticable, shall be estimated monthly

as accurately as practicable, and the amount of such monthly estimates and the basis upon which each of said estimates is made shall be reported monthly to the Hope Company.

Tenth. The Ohio Company further undertakes and agrees that the Hope Company shall at all times through its agents and representatives have access to all meters used by the Ohio Company or by companies to which it sells gas to measure the amount of gas sold to consumers, whether for domestic purposes or for manufacturing purposes, and to all pipes, appliances and apparatus used by such companies in transporting, distributing and delivering gas, with the right to require the Ohio Company to examine, test and repair such meters, pipes and apparatus, on the refusal, delay or failure of the Ohio Company so to do, the Hope Company, by its duly authorized agents and employes, shall have access to such meters, pipes, appliances and apparatus, with the right to examine, test, repair and replace the same (in workmanlike manner as it would its own meters and appliances) but at the cost of the Ohio Company; the Hope Company by its properly accredited representatives shall also at all times have the right to examine the books of account of the Ohio Company and of each of the companies to which the Ohio Company supplies natural gas, so far as said books of account in any way relate to the purchase or distribution of natural gas.

Eleventh. It is mutually understood and agreed that for the purposes of this contract "gas sold for domestic purposes" and "gas sold to domestic consumers" shall be deemed to include all gas sold for household use or at the same rates and upon the same terms and conditions upon which gas is sold for household use; also gas sold to churches, schools and similar institutions at reduced rates
108 but for the same purposes and upon the same terms and conditions for which and upon which gas is sold for household use; also gas sold for street lighting, and that the terms "manufacturing gas" and "gas sold for manufacturing purposes" shall be deemed to include all gas, other than as aforesaid, sold upon special terms and conditions; it is also agreed that where this contract uses the words "consumers of the Ohio Company," or "consumers supplied by the Ohio Company," such words or terms include also consumers of local distributing companies supplied with gas by the Ohio Company.

Twelfth. Any gas that may be used by the Ohio Company or any company which it supplies with natural gas, for the operation of compressing stations or other plants owned by it, or for lighting or heating its own buildings, shall be deemed to be gas sold for domestic purposes, at the prevailing domestic rates, unless a special agreement is made in reference thereto with the Hope Company.

Thirteenth. Notwithstanding anything in this contract contained, the Ohio Company may continue to market the gas from certain walls in Mahoning County in the State of Ohio now being operated by it, but such gas is to be measured before commingling in a manner satisfactory to the Hope Company and is to be deemed, for the pur-

poses of this contract, as gas delivered for manufacturing purposes at the average rate currently charged per month for manufacturing purposes and deducted at that rate from the monthly settlements with the Hope Company.

All contracts made by the Ohio Company or companies supplied by it with gas for the sale of gas for manufacturing purposes shall be submitted to the Hope Company and, if approved by the Hope Company, the provisions of this contract shall apply thereto; if, however, any of said contracts are not approved by the Hope Company, the Ohio Company shall be under no obligation to purchase and take from the Hope Company, nor shall the Hope Company be under any obligation to sell and deliver to the Ohio Company, the amount of gas requisite to fulfill the same, and this contract shall in no wise restrict the right of the Ohio Company to enter into such
109 contracts and to purchase and supply from other sources the natural gas requisite for the fulfillment of the contracts which the Hope Company has not approved.

When the production of the Hope Company shall have declined so that the amount of gas available for delivery hereunder during January and February will not maintain a pressure of 225 pounds at the Ohio River on the lines of the Ohio Company as now constructed, and will not supply the amount of gas requisite for the domestic consumers of the Ohio Company during such months, the amount of gas which the Ohio Company shall be obligated to purchase and take from the Hope Company and the Hope Company to sell and deliver hereunder on account of domestic consumption after any January and February in which there is such a deficiency in the available supply, may at the option of the Ohio Company, be limited to the proportion that the amount delivered by the Hope Company during said months of January and February bears to the amount which was required by said Ohio Company in said months for the supply of its domestic consumers (not exceeding, however, the amount which could have been transported under the pressure as aforesaid). Said option shall be exercised on or before June 1st by written notice from the Ohio Copmany to the Hope Company.

Notwithstanding the exercise of such option, the provisions of Paragraph Sixteenth hereof shall nevertheless continue applicable for the purpose of determining the price to be paid for gas actually delivered by the Hope Company.

Fourteenth. It is mutually understood and agreed that the requirements of domestic consumers of the Ohio Company shall be fully supplied from the gas delivered hereunder in preference to manufacturers purchasing gas for manufacturing purposes, and that the Hope Company can be required to supply gas to be used for manufacturing purposes only where the same is sold under special contracts which have first been submitted to and approved in writing by the Hope Company and which expressly provide that natural gas will be supplied thereunder only in so far as the same is not necessary to
110 meet the requirements of domestic consumers supplied through pipe lines of the Ohio Company.

Fifteenth. The Ohio Company undertakes and agrees that it will pay to the Hope Company for natural gas sold and delivered to it by the Hope Company hereunder as follows:

(*a*) For all natural gas sold and delivered to the Ohio Company to enable it to meet the requirements of its domestic consumers and the domestic consumers of companies which it supplies with gas, fifty per cent. of the amounts payable by such consumers therefor, provided, however, that the minimum amount to be received by the Hope Company for each One Thousand cubic feet of natural gas supplied by it for domestic consumers shall not be less than as follows, to-wit:

From March 1st, 1910, to May 31st, 1918, inclusive, 15 cents.
From June 1st, 1918, to May 31st, 1920, inclusive, 17½ cents.
From and after June 1st, 1920, for each successive period of five years, a price not less than 110 per cent. of the highest price received by the Hope Company in the last preceding period of 5 years.

(*b*) For all natural gas sold and delivered to the Ohio Company to enable the Ohio Company, or companies which it supplies with gas, to fulfill contracts made with the consent of the Hope Company for the sale of gas for manufacturing purposes, sixty per cent. of the amounts payable therefor by the manufacturers or other consumers by whom the same is purchased.

Sixteenth. It is mutually understood and agreed that whenever the Ohio Company, in addition to the gas purchased by it from the Hope Company, is obtaining gas from other sources (under the right as provided in the Thirteenth Paragraph hereof), nevertheless, for the purpose of computing the amounts to be paid to the Hope Company hereunder, all gas sold by the Ohio Company for domestic consumers, shall, up to the full amount of gas supplied by the Hope Company, be deemed to be gas obtained from the Hope Com-
111 pany.

In all cases where gas is obtained from other sources and is commingled with gas obtained from the Hope Company prior to delivery to consumers, it is necessary that the gas obtained from the Hope Company, as well as the gas from other sources, shall be measured before such commingling takes place; it is agreed, therefore, that such measurement of the gas obtained from the Hope Company at such time shall be by Pitot tubes or other accurate devices of standard registering type as may be agreed upon, to be installed and maintained at the expense of the Hope Company as nearly as possible at the junction of the lines of the Hope Company with the lines of the Ohio Company, but on the West Virginia side of the Ohio River. The gas obtained from other sources shall be measured at the expense of the Ohio Company before the commingling takes place, in a manner satisfactory to the Hope Company, and the Ohio Company shall give the Hope Company 24 hours notice specifying the exact time when such gas will be turned into the lines of the Ohio Company.

The proportion of gas delivered to consumers that has been obtained from each source shall be determined as follows, viz:

(*a*) The Ohio Company shall ascertain the amount of gas obtained in each month from all sources and measured before commingling; the percentage by which such total exceeds the amount of gas payable for by all consumers as measured by the regular reading of meters in the same month shall be used for the purposes of this contract as the "percentage of loss" for such month.

(*b*) If the amount of gas furnished by the Hope Company during any month as measured at the State Line, less the percentage of loss, exactly equals or exceeds the amount of gas payable for by domestic consumers to the Ohio Company for such month, then all gas payable for by such domestic consumers in such month shall be deemed to have been gas delivered by the Hope Company for domestic consumers at the rate stipulated in clause "*a*" of the fifteenth paragraph hereof; but if the amount of gas furnished by the Hope Company during any month as measured at the State Line, less the percentage of loss, is less than the amount of gas payable for by domestic consumers in such month, then the Hope Company shall be paid for all gas delivered in such month as measured at the State Line, less the percentage of loss, at the average rate payable by domestic
112 consumers to the Ohio Company for such month.

(*c*) If the amount of gas furnished by the Hope Company during any month as measured at the State Line, less the percentage of loss, exceeds the amount of gas payable for to the Ohio Company in such month by domestic consumers, then such excess amount shall be the amount of gas furnished by the Hope Company for manufacturing purposes and shall be paid for at the rate stipulated for in clause "*b*" of the fifteenth paragraph hereof.

(*d*) If the amount of gas furnished from all sources in any month, as measured before commingling, is less than the amount of gas payable for in such month by all consumers to the Ohio Company (which is a probable condition in spring months), then the amount of gas to be paid for to the Hope Company by the Ohio Company for such month shall be determined as follows:

The percentage which the amount of gas furnished by the Hope Company measured at the State Line bears to the total amount of gas furnished by all sources, measured before commingling, shall be ascertained, and such percentage of the total amount of gas payable for by all consumers to the Ohio Company in such month shall then be computed; if the resulting computation is equal to or larger than the amount of gas payable for to the Ohio Company by domestic consumers for such month, then all gas payable for by domestic consumers to the Ohio Company for such month shall be deemed to be the gas delivered by the Hope Company at the rate set forth in clause "*a*" of the fifteenth paragraph hereof; and the excess of such resulting computation over the amount payable for in such month to the Ohio Company by domestic consumers, shall be deemed to be gas delivered by the Hope Company for manufacturing purposes at

the rate set forth in caluse "*b*" of the fifteenth paragraph hereof; if, however, the said computation is less than the amount of gas payable for to the Ohio Company in such month by domestic consumers, then the Hope Company shall be paid for all of the gas contained in such computation at the average rate per thousand cubic feet paid to the Ohio Company by domestic consumers in such month.

Seventeenth. Where gas is measured by Pitot tubes, meters or other devices, such measuring instruments shall be of a standard registering type and the gas shall be measured on a basis of
113 10 ounces pressure to the square inch above 14.4 pounds atmospheric pressure, according to Boyle's law for the measurement of gas at varying pressures, without correction for temperature or barometric conditions. Each company shall have full access to the measuring stations at all times with the right to keep an employe or employes there for the purpose of checking the gas measurements, where Pitot tubes are used they shall be read at 15 minute intervals throughout each day of 24 hours, and duplicate statements of the daily readings shall be mailed daily to each party; where meters are used such meters shall be read by the Ohio Company daily, or as often as the meters require, but each party shall have constant access to the meters.

If either party challenges the accuracy of any meter or other device in use under the sixteenth paragraph of this contract, and desires to have the meter or such device tested or repaired, the Ohio Company shall test and repair the same in the presence and to the satisfaction of the Hope Company, or a representative, if the Hope Company wishes to exercise the right to be present or to be represented at such test. Before taking out such meter or device for test or repairs, a correctly registering meter or other agreed device shall be set in its place, and adjustment and settlement for the inaccurate measurements by the defective meter shall be made at the regular monthly periods on the basis of the amount of gas registered at like pressures for like periods of time when the meter was registering accurately.

Eighteenth. The Ohio Company undertakes and agrees that on or before the 25th day of each month it will furnish to the Hope Company a detailed statement of the amount of gas charged to its domestic consumers during the preceding month, showing separately the amount so supplied in each city and town supplied by it either directly or through distributing companies; and the rates at which gas is sold in each of said cities and towns; the number of domestic consumers in each of said cities and towns; the amounts charged during the preceding month to each consumer using gas for manufacturing purposes; whether any gas has been obtained from other sources; and if so the amount of gas obtained from the Hope Company
114 and the amount of gas obtained from other sources determined as hereinbefore provided; and all such other data as the Hope Company may reasonably require or as may be necessary to enable the Hope Company to determine the amount which it is entitled to receive for gas supplied by the Hope Company to the

Ohio Company and charged to consumers during the preceding month. The Ohio Company undertakes and agrees that it will pay in semi-monthly installments the amount due to the Hope Company for all gas delivered by the Hope Company to the Ohio Company during the preceding month; the first installment shall be paid on or before the 15th of the month and shall be 75 per cent. of the total amount due for the month, approximated as fairly as may be at the time by the Ohio Company; the second installment or balance shall be paid in full on the 27th day of the month; the Ohio Company also agrees that the amounts of gas charged to consumers during each month shall be true statements of the amounts actually delivered to consumers determined as is provided in Paragraph Ninth hereof.

Nineteenth. It is understood and agreed that the minimum price of fifteen cents per thousand cubic feet hereinabove provided for is based upon an assumed pressure not exceeding 8 ounces above atmospheric, and that in case of the delivery of gas to consumers at a pressure exceeding 8 ounces above atmospheric, the amount of gas to be charged to such consumers shall be increased proportionately to the increase in the density of the gas.

Twentieth. The Ohio Company covenants to use diligent effort to maintain and keep up its deliveries of natural gas under the spirit and intention of this agreement in order that the natural gas which the Hope Company is prepared to deliver hereunder may find a continuous market.

Twenty first. This contract shall be binding upon the parties hereto and their successors and assigns, respectively, provided, however, that in case the gas distributing system now or hereafter owned or controlled by the Ohio Company is broken up, so that parts thereof are vested in different owners, the Hope Company, at its option, shall have the right to terminate this contract.

115 & 116 In witness whereof, the parties hereto have hereunto caused their corporate names to be signed by their respective Presidents or Vice Presidents and their respective seals to be hereunto affixed by their respective Secretaries the day and year first above written.

HOPE NATURAL GAS COMPANY,
By JOHN G. PEW,
Vice President.

Attest:

CHRISTY PAYNE,
Secretary.

THE EAST OHIO GAS COMPANY,
By M. B. DALY,
President.

Attest:
N. V. SHULTEIS,
Secretary.

EXHIBIT D. March 1st, 1910. Christy Payne.

116*a* PENNSYLVANIA EXHIBIT 20.

Offered at p. 225 of Printed Record by Witness Sullivan.

Contract Between the Mountain State Gas Company and the River Gas Company Dated April 1, 1910.

117 EXHIBIT A. April 15th, 1910. Christy Payne, Secretary.

This agreement, Made and entered into this 1st day of April, A. D. 1910, by and between the Mountain State Gas Company, a West Virginia Corporation, party of the first part, and The River Gas Company, also a West Virginia Corporation, party of the second part,

Witnesseth: Whereas the party of the second part has sold and delivered on this day to the party of the first part all of its property situate in the State of West Virginia, consisting of pipe lines, natural gas distributing plants, and interests in oil and gas producing properties, and as a part of the consideration from the sale, a contract was to be entered into whereby the party of the first part should agree to supply to the party of the second part all of the natural gas which the party of the second part shall require for its consumers in the State of Ohio, as hereinafter set forth, and

Whereas, the Boards of Directors of the parties hereto have in meetings separately assembled on the 15th day of April, 1910, duly adopted and approved this instrument as the agreement so agreed to be entered into as a part of the consideration for said sale, and have authorized their respective officers to execute the same, to take effect as of the 1st day of April 1910,

Now therefore, for and in consideration of the premises, and of the mutual covenants and agreements herein contained to be faithfully performed by each party, its successors and assigns, to the other, the parties hereto, the party of the first part being hereinafter called the "Selling Company and the party of the second part the Buying Company," have agreed and do hereby mutually agree as follows:

118 First. The Selling Company undertakes and agrees, during the continuance of this contract, to sell and deliver to the Buying Company, and the Buying Company undertakes and agrees to purchase and take from the Selling Company,

(*a*) All the natural gas required by the Buying Company for the supply of all of the consumers of the Buying Company paying domestic rates;

(*b*) Such amounts of natural gas as may be required by the Buying Company to fulfill its contracts made with the consent of the Selling Company for the sale of gas at special rates for manufacturing purposes;

Provided, however, that the Selling Company shall not be obligated to sell and deliver or the Buying Company to purchase and take gas in excess of the amounts currently required for the aforesaid purposes, or in excess of the amount which can be transported and delivered at a safe pressure through the pipe lines of the Selling Company now constructed from the gas fields of West Virginia to the Junction points with the lines of the Buying Company at the State Line between the States of West Virginia and Ohio. At the option of the Selling Company, however, it may increase the capacity of its lines to meet any increased requirements of the Buying Company.

It is further provided that the Buying Company shall have the right to produce and market gas from any gas lands or leases which it now owns in the State of Ohio, and to market from lands in Ohio any gas which it has heretofore contracted to purchase, but such gas shall be accurately and separately measured by meter by the Buying Company and a statements of the amount so measured based upon a pressure of eight ounces shall be rendered at the end
119 of each month by the said Buying Company to the said Selling Company.

Second. The natural gas to be sold and delivered hereunder shall be delivered by the Selling Company to the Buying Company at the boundary line between the States of Ohio and West Virginia, where the lines of the Selling Company are now connected to the lines of the Buying Company.

Third. No dominion or control over the natural gas delivered under this contract shall remain in the Selling Company after the gas passes the points of delivery above stated, nor shall the Selling Company be responsible for or on account of anything that may hereafter be done, happen or arise touching said gas; and the Buying Company undertakes and agrees that it will at all times and from time to time keep free, same harmless and indemnify the Selling Company from any and all manner of claims, suits and damages on account of any conduct, act or thing touching the said gas after it has left the said points of delivery.

Fourth. The Selling Company undertakes and agrees that at all times during the continuance of this contract it will use all reasonable diligence in developing and extending its gas leases and properties and in obtaining gas therefrom for the purpose of fulfilling its obligations hereunder; and will provide and maintain in good order and condition all such compressing stations, pipe lines and other facilities in the State of West Virginia to deliver the gas required by the Buying Company up to the capacity at a safe pressure of the pipe lines of the Selling Company now con-
120 structed to said delivery point.

Fifth. Where either party to this contract fails to perform any obligation herein assumed by it, and such failure is due to the Acts of God, or a public enemy, strikes, riots, injunctions or other inter-

ference through legal proceedings, breakage or accident to machinery or lines of pipe, washouts, earthquakes, storms, freezing of lines or wells, sudden or unfor-seen failure of gas wells, or to any cause not due to the fault of such party, or is caused by the necessity for making repairs or alterations in machinery or lines of pipe, such failure shall not be deemed to be a violation by such party of its obligations hereunder, but such party shall use due diligence to again put itself in position to carry out all of the obligations, which, by the terms hereof, it has assumed.

Sixth. This contract shall continue between the parties hereto so long as the Selling Company produces gas in marketable quantities from gas fields owned or leased by it in West Virginia, but the Selling Company reserves the right to make and enter into contracts with other companies for the sale to such companies of natural gas and the right to prefer the domestic consumers directly supplied with natural gas through the various distributing systems now constructed and owned by the Selling Company in West Virginia, or that may be hereafter constructed and owned by it; and in the ordinary course of business the Selling Company shall have the right to sell and dispose of all or any part of the gas properties now or hereafter owned or leased by it.

121 Seventh. It is mutually understood and agreed that the Buying Company shall keep the Selling Company at all times fully informed of all facts tending to show the amount of natural gas which will be necessary from time to time to supply its requirements hereunder, and that so long as the Selling Company exercises due diligence in making provision to supply and does supply the amount of natural gas estimated to be necessary to meet such requirements, it shall not be liable by reason of its failure to supply gas in excess of said estimated amount.

Eighth. The Buying Company undertakes and agrees at all times during the continuance of this contract to keep its lines from the Ohio River to the cities and towns supplied by it and all branches therefrom and the various distributing systems connected therewith, in good order and condition, so as to reduce, as far as possible, the waste and escape of gas, and that all gas supplied by it to domestic consumers or for manufacturing purposes shall be delivered at a pressure not to exceed eight ounces and measured by standard meters, which it will install and keep in good order and condition; that all of said meters used for measuring gas sold for domestic purposes shall be read at least once in each calendar month, and that meters used for measuring gas sold for manufacturing purposes, pursuant to the provisions hereof, shall be read daily, and that reports of the readings of all meters shall be furnished monthly to the Selling Company. The measurement of gas sold for lighting streets and for other purposes where measurement by meters is impracticable shall be estimated monthly and the amount of such estimates reported to the Selling Company.

122 Ninth. The Buying Company further undertakes and agrees that the Selling Company shall at all times through its agents and representatives have access to all meters, pipe lines and appliances used throughout the plants of the Buying Company, either in selling or in buying gas, and shall have the right to have such meters examined and tested, and that the Selling Company by its properly accredited representatives shall, at all times, have the right to examine the books of account of the Buying Company so far as such books of account in any way relate to the purchase or distribution of natural gas.

Tenth. It is mutually understood and agreed that for the purposes of this contract the terms "Manufacturing gas" and "gas sold for manufacturing purposes" shall be deemed to include gas sold under special contracts and at special rates exclusively for manufacturing purposes, and the terms "gas sold for domestic purposes" and "gas sold to domestic consumers" shall be deemed to include all gas sold to consumers by the Buying Company, except gas sold for manufacturing purposes, as herein defined.

Eleventh. Any gas that may be used by the Buying Company for the operation of compressing stations or other plants owned by it, for lighting or heating its own buildings, shall be deemed to be gas sold for domestic purposes, unless a special agreement is made in reference thereto with the Selling Company.

Twelfth. It is mutually understood and agreed that insofar as the Buying Company does not obtain from the Selling Company all the gas requisite for the supply of it- consumers, it may obtain the amount of gas required to supplement the supply from other sources; but such supplementary supply shall always be limited in
123 volume to the amount which the Selling Company is currently failing to supply, and shall be measured separately and accurately by the Buying Company by meter, and upon a basis of 8 ounces pressure, and a monthly statement of the amount shall be rendered by the Buying Company to the Selling Company, at the end of each month.

Thirteenth. It is mutually understood and agreed that the Selling Company will sell and deliver to the Buying Company, and the Buying Company will purchase and take from the Selling Company the amount of natural gas sold for manufacturing and street lighting purposes by the Buying Company under special one year contracts, each of which *have* been submitted to and approved in writing by the Selling Company. But all such special contracts for gas sold for manufacturing purposes shall provide that natural gas will be supplied thereunder only in so far as the same is not necessary to meet the requirements of domestic consumers supplied through pipe lines of the Buying Company.

Fourteenth. The Buying Company undertakes and agrees that it will pay to the Selling Company for natural gas sold and delivered to it by the Selling Company hereunder as follows:

(*a*) 66 2/3 per centum of the gross receipts of the Buying Company from its sales of natural gas to domestic consumers, provided always that during the period from April 1st, 1910, to and including March 31st, 1915, the price received by the Selling Company from the Buying Company shall at no time be less than 12 cents for each one thousand cubic feet; and that during the period from April 1st, 1915, to and including the 31st day of March, 1920, the price received by the Selling Company from the Buying Company shall at no time be less than 14 cents for each one thousand cubic feet of gas; and that during the period from April 1st, 1920, to and including the 31st day of March, 1925, the price received by the Selling Company from the Buying Company shall at no time be less than 18 cents for each one thousand cubic feet of gas;
124 and that for the period from and after April 1st, 1925, if the Selling Company in making diligent effort in its production of gas for its consumers, whoever and wherever they may be, finds that it is compelled to go farther afield with its pipe line, or finds from any cause that the cost of producing its gas on the average throughout its field has materially increased, then the price last named to be received by the selling Company from the Buying Company shall be increased from year to year so as to yield to the Selling Company a larger price in the same proportion that the cost of producing the gas has increased, or shall increase from year to year over the cost on the 1st day of April, 1920. And if the parties hereto cannot agree upon the amount of such increased percentage, then the question of the amount of the increase in the rate, if any, shall be submitted to arbitrators, one to be chosen by each party and the two so chosen, if they cannot agree, to select an umpire; the award of any two of the arbitrators to be final and conclusive, and the cost of the award to be borne equally by the parties hereto.

(*b*) Seventy-five per centum of the gross receipts of the Buying Company from its sales of natural gas for manufacturing purposes.

Provided that there shall be first deducted from the gross receipts of the Buying Company the amount of money received by it for gas produced from its own gas properties in the State of Ohio, or from gas secured by it to supplement the supply received during
125 a shortage of the deliveries by the Selling Company, which deduction shall be based upon the lowest rate received for gas currently sold by the Buying Company to its consumers. It is provided, however, that the Selling Company may erect pitot tube or meter measuring stations on the West Virginia side of the Ohio River at any or all of the river crossings and connect the same to any or all of the pipes through which gas is sold to the Buying Company by the Selling Company in order to measure the gas so sold and there delivered, to ascertain the amount of leakage and unaccounted for gas occurring in the lines, meters and distributing plants of the Buying Company; if it has ascertained that such unaccounted for gas exceeds 2 per centum of the volume of gas sold and accounted for by the Buying Company, then the Buying Company shall pay to the Selling Company for all unaccounted for gas above 2 per centum

of the gross volume of natural gas sold and accounted for by the Buying Company such payments to be made at the monthly periods herein set forth and at the average price received for the month to the Selling Company for all gas accounted for by the Buying Company. The gas shall be measured at said pitot tube or meter stations on a basis of eight ounces to the square inch according to Boyle's Law for the measurement of gas at varying pressures, and the cost of maintaining and operating the said pitot tube or meter stations, which shall primarily be under the control of the Selling Company during all the time that the said leakage exceeds said per centum, shall be borne by the parties hereto equally, and the Buying Company as well as the Selling Company, shall have full access to the stations at all times with the right to keep an employee or employees there for the purpose of checking the gas measurements.

126 Fifteenth. The Buying Company undertakes and agrees that on or before the fifteenth day of each month it will furnish to the Selling Company a detailed statement of the gas received by it during the preceding month and of the amounts payable therefor, and within five days thereafter will pay such amount to the Selling Company; the Buying Company agrees to furnish any other reasonable data that the Selling Company may require.

Sixteenth. It is mutually understood and agreed that in case the Buying Company shall fail to pay to the Selling Company any amounts that may be due and payable hereunder to the Selling Company within twenty (20) days after such amount becomes due and payable, or shall fail to render the statements required hereunder, or to perform the covenants of this agreement, the Selling Company shall have the right, without cancelling this contract or waiving any of its rights hereunder, to suspend the delivery of natural gas hereunder until all amounts due to it are paid, or at its option shall have the right to terminate this contract on thirty (30) days' notice to the Buying Company without prejudice to its right to collect the amounts due it at the time of such termination for any gas previously furnished hereunder.

Seventeenth. This contract shall be binding upon the parties hereto and their successors and assigns, respectively; provided, however, that in case the gas distributing system now or hereafter owned or controlled by the Buying Company is broken up, so that parts thereof are vested in different owners, the Selling Company, at its option, shall have the right to terminate this contract.

127 & 128 In witness whereof the parties hereto have hereunto caused their corporate names to be signed by their respective Vice Presidents and their respective seals to be hereunto affixed by their respective Secretaries the day and year first above written.

MOUNTAIN STATE GAS COMPANY,
By JOHN TONKIN,
Vice President.

Attest:
CHRISTY PAYNE,
Secretary.

THE RIVER GAS COMPANY.
By JOHN G. PEW,
Vice President.

Attest:
CHRISTY PAYNE,
Secretary.

128*a* PENNSYLVANIA EXHIBIT 21.

Offered at p. 225 of Printed Record by Witness Sullivan.

Contract Between the Hope Natural Gas Company and Fayette County Gas Company Dated May 1, 1910.

129 Executed in Duplicate.

This agreement, Made and entered into this 1st day of May, A. D. 1910, by and between the Hope Natural Gas Company, a West Virginia corporation, party of the first part, and the Fayette County Gas Company, also a West Virginia corporation, party of the second part,

Witnesseth, That whereas the party of the second part is the owner of franchises or rights in and is supplying natural gas to the following cities and towns in the State of Pennsylvania, viz.: Uniontown, Connellsville, Scottdale, Mt. Pleasant, Tarrs, Alverton, New Stanton, Hopewood, McClellantown, Masontown, Dawson, Vanderbilt and Youngwood, and owns and maintains a 12-inch pipe line to the State line between the States of Pennsylvania and West Virginia, and

Whereas the party of the first part is the owner of gas leases, properties, wells and pipe lines in the State of West Virginia, with a 12-inch pipe line extending to and meeting the pipe line of the party of the second part at the said State Line, and

Whereas, the party of the second part desires to buy from the party of the first part, and the party of the first part desires to furnish to the party of the second part the natural gas to be supplied to the consumers of the party of the second part in said cities and towns,

Now therefore, for and in consideration of the premises, and of the mutual covenants and agreements herein contained, to be faithfully performed by each party, its successors and assigns, to the other, the parties hereto, the party of the first part hereinafter called the "Selling Company" and the party of the second part the "Buying Company", have agreed and do hereby mutually agree as follows:

130 First. The Selling Company undertakes and agrees during the continuance of this contract, to sell and deliver to the Buying Company, and the Buying Company undertakes and agrees to purchase and take from the Selling Company all of the natural gas required by the Buying Company for the supply of all

of the consumers of the Buying Comnpay, which it now has or may hereafter acquire, paying domestic rates in the cities, towns and villages now furnished with natural gas by the Buying Company; providing, however, that the Selling Company shall not be obligated to sell and deliver, or the Buying Company to purchase and take gas in excess of the amounts currently required for the aforesaid purpose.

The Selling Company also undertakes and agrees for the term of 2 years from and after May 1st, 1910, to sell and deliver to the Buying Company, and the Buying Company undertakes and agrees to purchase and take from the Selling Company at the special price hereinafter agreed upon an additional volume of gas in the five summer months from May 1st, 1910, to and including September 30th, 1910, and in the six summer months from April 1st, 1911, to and including September 30th, 1911, not to exceed 3,000,000 cubic feet per day, to be supplied for mill use under a contract now binding upon the Buying Company. For the purposes of this contract domestic gas is hereby defined as all gas sold to consumers at rates other than special rates to manufacturers and boilers which have been agreed to by the Selling Company.

Second. The 12 inch line of the party of the second part in the State of Pennsylvania meets and is joined to the 12 inch West Virginia line of the party of the first part at the State Line between the States of Pennsylvania and West Virginia, upon the lands of M. L. Core, situate along the boundary line of the District of Battelle, in Monongalia County, West Virginia, with the town-
131 ship of — in Greene County, Pennsylvania. The junction point of the pipe lines of the parties hereto shall be known and designated for the purposes of this contract as Core Station, and at that point there shall be erected a Pitot tube measuring station for the purpose of measuring the gas sold and delivered to the Buying Company hereunder; the said station shall be erected by the Selling Company, connected to the lines of each party and fully equipped, ready to be put into operation on the 1st day of May, 1910; the said Station shall thereafter be maintained and operated by the Selling Company, but the Buying Company shall have free access to the station at all times, with the right to employ men to read or check the readings of the Pitot tubes; the Buying Company shall reimburse the Selling Company for one half of the cost of erecting the station, and the cost of maintaining and operating the same from time to time shall be borne equally by the parties hereto. The reading of the Pitot tubes shall be under the joint control of the parties hereto, and shall be made at 15 minute intervals during each day of 24 hours; duplicate reports of the daily readings shall be mailed daily to each party.

Third. The Buying Company undertakes and agrees that it will pay to the Selling Company for the natural gas sold and delivered to it by the Selling Company, upon the basis of the measurements recorded by said Pitot tubes, calculated upon a pressure of 12 ounces

to the square inch, according to Boyle's Law for the measurement of gas at varying pressures, the following rates and prices, viz:

(a) For all gas sold and delivered from the 1st day of May, 1910, to and including the 30th day of April, 1920, that price from
132 month to month for each 1,000 cubic feet of gas equal to 50 per centum of the average price per thousand cubic feet charged from month to month by the Buying Company to its domestic consumers;

Provided, always, that during the period from May 1st, 1910, to and including April 30th, 1915, the price received by the Selling Company from the Buying Company shall at no time be less than 12½ cents for each 1,000 cubic feet; and that during the period from May 1st, 1915, to and including April 30th, 1920, the price received by the Selling Company from the Buying Company shall at no time be less than 14 cents for each 1,000 cubic feet of gas; and provided also that from the 1st day of May, 1910, to and including the 30th day of September, 1910, and from the 1st day of April, 1911, to and including the 30th day of September, 1911, for the gas sold by the Selling Company to be delivered by the Buying Company for mill use, but not exceeding 3,000,000 cubic feet per day, under a contract now binding upon the Buying Company, the price to be paid the Selling Company for gas delivered to the mill shall be 75 per centum of the rate received by the Buying Company from the mill instead of the price above stipulated to be paid for all gas; but the price received by the Selling Company from the Buying Company for such mill gas, shall at no time be less than 7½ cents for each 1,000 cubic feet of gas. The gas so sold for mill use shall be accurately measured by the Buying Company by standard meters at a pressure not exceeding 8 ounces, and the amount of gas so measured, but not exceeding 3,000,000 cubic feet each day, shall be deducted monthly from the amount of gas registered by the Pitot tube station;

133 (b) For all gas sold and delivered on and after the 1st day of May, 1920, that price from month to month for each 1,000 cubic feet of gas, equal to 55 per centum of the average price per thousand cubic feet charged from month to month by the Buying Company to its domestic consumers; provided that the price received by the Selling Company from the Buying Company on and after the 1st day of May, 1920, shall at no time be less than 16½ cents for each 1,000 cubic feet of gas;

Provided also that after the 1st day of May, 1920, if the Selling Company in making diligent effort in its production of gas for its consumers, whoever and wherever they may be, is compelled to go farther afield with its pipe lines than the counties of Monongalia, Marion, Taylor, Harrison, Wetzel, Marshall, Tyler, Lewis, Upshur, Doddridge, Wirt, Pleasants, Wood, Ritchie, Calhoun, Gilmer, Braxton and Webster, or finds from other causes that the cost of producing its gas on the average throughout its field has materially

increased, then the percentage last named shall be increased so as to yield to the Selling Company a larger price, in the same proportion that the cost of producing the gas has increased over the cost at the time of the making of this contract. And if the parties hereto cannot agree upon the amount of such increased percentage, then the question of the amount of the increase in the rate, if any, in order to fix the proper rate at which the profit in handling the gas from the well to the consumer should be equitably divided between the parties hereto, shall be submitted to arbitrators, one to be chosen by each party and the two so chosen, if they cannot agree,
134 to select an umpire; the award of any two of the arbitrators to be final and conclusive, and the cost of the award to be borne equally by the parties hereto.

Fourth. The Buying Company agrees to pay to the Selling Company at its offices in Pittsburgh, Pennsylvania, on or before the 15th day of each month for all gas sold and delivered to it in the preceding month.

Fifth. The Buying Company agrees to keep the meter or meters through which it delivers said limited quantities of gas for mill use, in a condition of good repair for accurate measurement of gas, and the Selling Company may have access to said meter or meters with every reasonable opportunity of examining and testing the same. Such meters shall be read daily and monthly reports of the readings of said meter or meters shall be rendered the Selling Company by the Buying Company on or before the 5th day of each month. If the Selling Party challenges the accuracy of any such meter and desires to have the meter tested or repaired, the Buying Company shall test and repair the same in the presence and to the satisfaction of the Selling Party or a representative, if such party wishes to exercise the right to be present or to be represented at such test; the cost of testing and repairing the meter shall be borne by the party challenging the accuracy of the same, if the meter on test proves to be correct, or within 3 per centum correct; but if the meter on test proves more than 3 per centum fast or slow, then the cost of testing and repairing the meter shall be borne by the Buying Company; for repair work the meter shall be shipped to Pittsburgh, Pennsylvania, or to any properly equipped shop of Selling Party, and there tested, adjusted or repaired.
135 During such time as the meter or meters are out of repair and while being tested, the gas taken shall be estimated until the repaired meter is installed, and adjustment and settlement shall be made between the parties hereto at the regular monthly periods on the basis of the amount of gas registered at like pressures for like periods of time when the meter was registering accurately.

Sixth. No dominion or control over the natural gas delivered under this contract shall remain in the Selling Company after the gas passes the point of delivery above stated, nor shall the Selling Company be responsible for or on account of anything that may be done, happen or arise touching said gas after its delivery; and the

Buying Company undertakes and agrees that it will at all times and from time to time keep free, save harmless and indemnify the Selling Company from any and all manner of claims, suits and damages on account of any conduct, act or thing touching the said gas after it has left the said point of delivery.

Seventh. The Selling Company undertakes and agrees that at all times during the continuance of this contract it will use all reasonable diligence in developing and extending its gas leases and properties and in obtaining gas therefrom for the purpose of fulfilling its obligations hereunder; and will use all reasonable diligence to provide and maintain in good order and condition all such compressing stations, pipe lines and other facilities in the State of West Virginia to deliver the gas at said Core Station in volume and pressure to meet the requirements of the Buying Company.

136 Eighth: It is mutually understood and agreed that the Buying Company shall keep the Selling Company at all times fully informed of all facts tending to show the amount of natural gas which will be necessary from time to time to supply its requirements hereunder, and that so long as the Selling Company exercises due diligence in making provision to supply and does supply the amount of natural gas estimated to be necessary to meet such requirements, it shall not be liable by reason of its failure to supply gas in excess of said estimated amount.

Ninth. It is mutually understood and agreed that in so far as the Buying Company during any period does not obtain from the Selling Company all the gas requisite for the supply of its consumers, it may obtain the amount of gas currently required to supplement the supply during such period from other sources. Should the Buying Company desire at any time to purchase additional plants or to extend its distributing system to embrace any other cities or towns not herein named, the Selling Company shall have the right to require the Buying Company to include such additional cities or towns within the terms of this contract. If at any time during the continuance of this contract the Buying Company requires in addition to the gas deliverable by the Selling Company hereunder more gas than the Buying Company can obtain from the territories now owned and leased by it or under contracts which it now has with other parties for the purchase of gas, it will purchase the additional gas required from the Selling Company so far as the Selling Company is willing to supply the same on terms as advantageous to the Buying Company as those on which the Buying Company can obtain same from other sources.

137 Tenth. Where either party to this contract fails to perform any obligation herein assumed by it, and such failure is due to the Acts of God, or a public enemy, strikes, riots, injunctions or other interferences through legal proceedings, breakage or accident to machinery or lines of pipe, washouts, earthquakes, storms, freezing of lines or wells, sudden or unforseen failure of gas wells, or to any causes not due to the fault of such party, or is caused by the

necessity for making repairs or alterations in machinery or lines of pipe, such failure shall not be deemed to be a violation by such party of its obligations hereunder, but such party shall use due diligence to again put itself in position to carry out all of the obligations, which, by the terms hereof, it has assumed.

Eleventh. This contract shall continue between the parties hereto for the term of Twenty (20) years from the date hereof, or as long thereafter as the Selling Company produces gas in marketable quantities from the counties named in the Third Section hereof, but the obligation of the Selling Company to deliver gas hereunder shall be limited to the amount which it is currently able to supply from its own production consistently with its present or future contracts with other purchasers, provided, however, that the Selling Company is to have the right at any and all times to supply the domestic consumers connected to its own system in West Virginia and to the systems in West Virginia which it is supplying with gas and to The East Ohio Gas Company and The Peoples Natural Gas Company to the extent of their requirements for domestic consumers, in preference to the Buying Company, but otherwise is not to give other purchasers the preference over the Buying Company.

The Selling Company reserves the right to surrender, exchange, sell and dispose of any part of the gas properties now or hereafter owned or leased by it; should, however, the Selling Company
138 desire to sell all of its gas properties, it shall do so only subject to this agreement.

Twelfth. It is mutually understood and agreed that in case the Buying Company shall fail to pay to the Selling Company any amounts that may be due and payable hereunder to the Selling Company within twenty (20) days after such amount becomes due and payable, or to perform the covenants of this agreement, the Selling Company shall have the right, without cancelling this contract or waiving any of its rights hereunder, to suspend the delivery of natural gas hereunder until all amounts due to it are paid, or at its option shall have the right to terminate this contract on thirty (30) days' notice to the Buying Company without prejudice to its right to collect the amounts due it at the time of such termination for any gas previously furnished hereunder.

Thirteenth. This contract shall be binding upon the parties hereto and their successors and assigns respectively; provided, however, that in case the gas distributing system now or hereafter owned or controlled by the Buying Company is broken up, so that parts thereof are vested in different owners, the Selling Company, at its option, shall have the right to terminate this contract.

139 & 140 In witness whereof the parties hereto have hereunto caused their corporate names to be signed by their respective Presidents and their respective seals to be hereunto affixed by their respective Secretaries, the day and year first above written.

HOPE NATURAL GAS COMPANY,
By JOHN G. PEW,
Vice President.

Attest:
CHRISTY PAYNE,
Secretary.

FAYETTE COUNTY GAS COMPANY,
By GEO. W. CRAWFORD,
President.

Attest:
H. C. REESER,
Secretary

140*a* PENNSYLVANIA EXHIBIT 22.

Offered at p. 360 of Printed Record by Witness Wallace.

Map Showing Natural Gas Property of the United Fuel Gas Company in West Virginia, Kentucky, and Ohio.

NOTE.—This was replaced by Pennsylvania Exhibit 39 D.

140*b* PENNSYLVANIA EXHIBIT 23.

Offered at p. 486 of Printed Record by Witness Reed.

Map Showing the Natural Gas Property of the Philadelphia Company in Pennsylvania and West Virginia January 1, 1920.

NOTE.—This was replaced by Pennsylvania Exhibit 39 F.

140*c* PENNSYLVANIA EXHIBIT 24.

Offered at p. 534 of Printed Record by Witness Angle.

Map Showing Fayette County Gas Company's Natural Gas System.

NOTE.—This was replaced by Pennsylvania Exhibit 39 A.

141 PENNSYLVANIA EXHIBIT 25.

Offered at p. 741 of Printed Record by Witness Batchelor.

Outline Map of Main Lines of the Natural Gas Company of West Virginia.

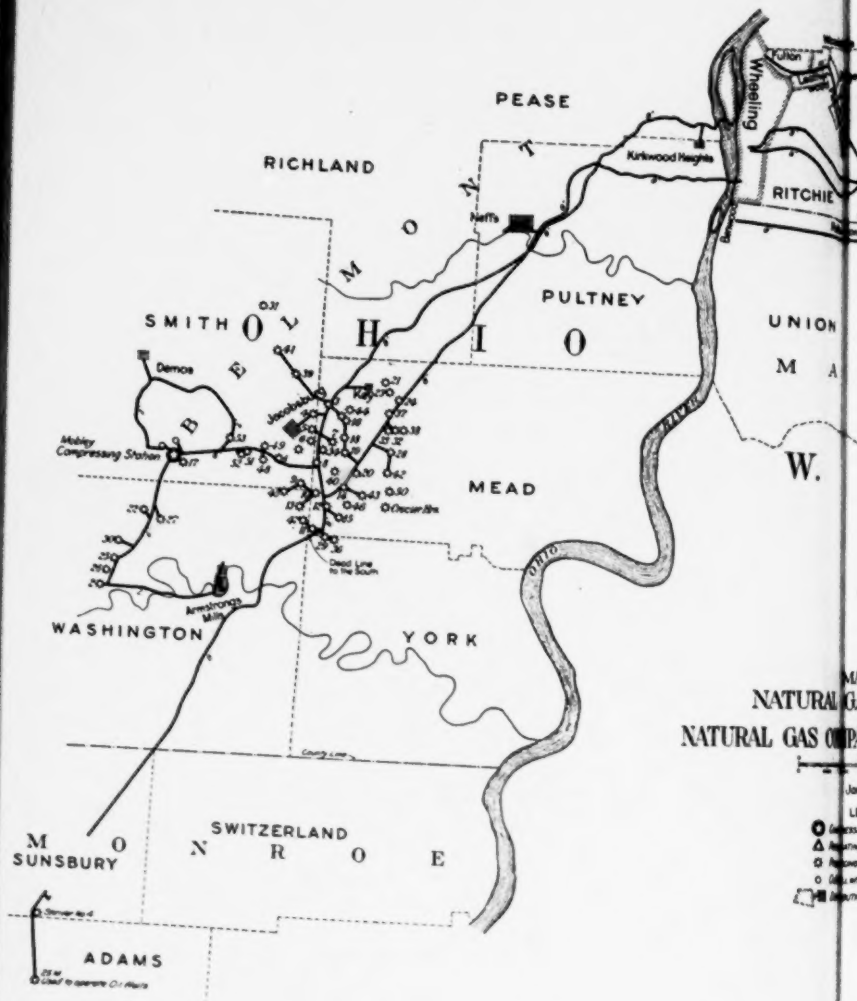
(Here follow reproductions of map of main line of the Natural Gas Company of West Virginia, marked page 141, and map showing natural gas property of West Virginia, southern division, marked page 141*a*.)

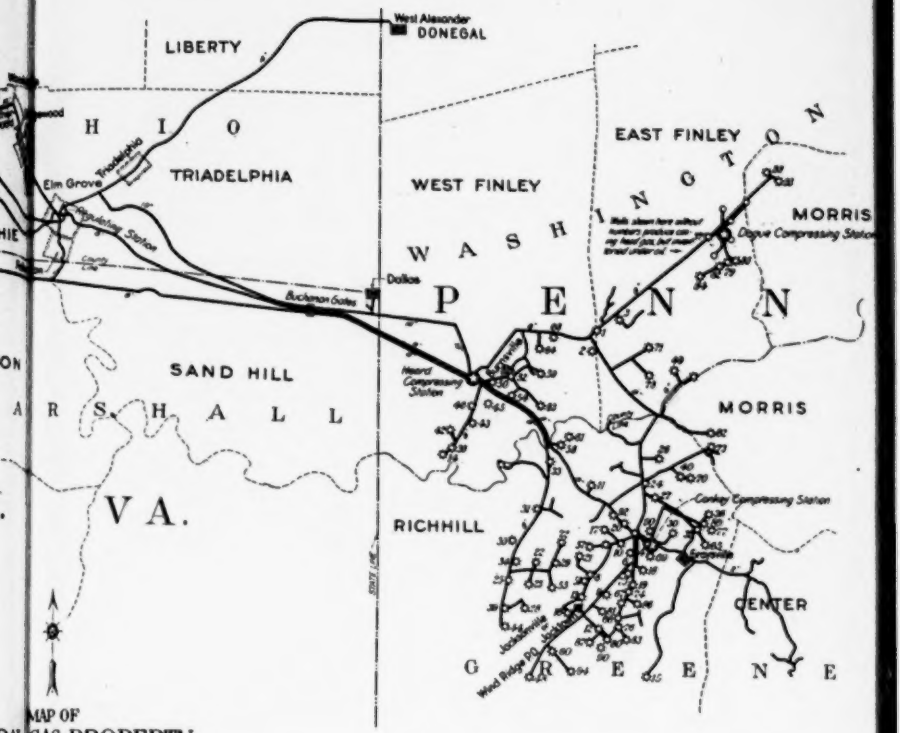
(Here follow Pennsylvania Exhibits 27 and 28, marked pages 141*b*-143, inclusive.)

FOLDOUT(S) IS/ARE TOO LARGE TO BE FILMED

Offered at p. 746 of Printed Record by Witness Batchelor.

Map Showing Natural Gas Property of the Natural Gas Company of West Virginia, Southern Division.





MAP OF
RAL GAS PROPERTY
OF
S COMPANY OF WEST VIRGINIA

Jan. 1, 1918

LEGEND

- Compressing Station
- Pumping Station
- Producing Gas Well
- Dry Well with Gas Casing Head
- Gasoline Plant

FOLDOUT(S) IS/ARE TOO LARGE TO BE FILMED

143*a*

PENNSYLVANIA EXHIBIT 29.

Offered at p. 817 of Printed Record by Witness Anderson.

Chart Showing Production and Consumption of Natural Gas in West Virginia.

(Here follow chart, Pennsylvania Exhibit No. 29, marked page 144, and Pennsylvania Exhibit No. 30, marked pages 144*a* and 145.)

PENNSYLVANIA EXHIBIT 31.

Offered at p. 822 of Printed Record by Witness Anderson.

Relation of Operated and Unoperated Leaseholds to Large and Small Companies in West Virginia.

PENNA. EX. 31—ANDERSON. 9/16/20. E. M.

August 19, 1920.

Statement Showing Relation of Operated and Unoperated Leaseholds of Large Interstate Natural Gas Companies and Small Local Intrastate Natural Gas Companies Doing Business in the State of West Virginia.

Company.	Unoperated acres.	Operated acres.	Total acres.	Unoperated.	Operated.
Carnegie Nat. G. Co	89,108	70,817	159,925	.....	.....
Col. Gas & Elec. Co	220,707	29,237	249,944	.....	.....
Hope Nat. Gas Co	690,094	326,420	1,016,514	.....	.....
Mfg. L. & H. Co	215,464	132,029	347,493	.....	.....
Ptbg. & W. Va. G. Co	209,128	108,198	317,326	.....	.....
Reserve Gas Co	4,664	51,468	56,132	.....	.....
United Fuel Gas Co	740,145	66,641	806,786	.....	.....
Total (7) large interstate Gas Cos	2,169,310	784,810	2,954,120	73.43%	26.57%
Total 20 small local intrastate Gas Cos	10,317	17,302	27,619	37.35%	62.65%

NOTE.—Based upon reports to the Board of Public Works for the Calendar year ending Dec. 31st, 1919. Many of the smaller companies fail to give this information.

PENNSYLVANIA EXHIBIT 32.

Offered at p. 823 of Printed Record by Witness Anderson.

Domestic Natural Gas Statistics for Year 1918 from Geological Survey Report, Domestic Gas Statistics from 1909 to 1919 from the Public Service Commission of West Virginia, and Domestic Gas Statistics of Various Companies in West Virginia.

147 PENNA. EX. 32—ANDERSON. 9/16/20. E. M.

Statement Showing Average Yearly Consumption of Natural Gas in M Cu. Ft. by Domestic Consumers.

From the 1918 Annual Report U. S. Geological Survey.

State.	No. of dom. consumers.	Volume, M cu. ft.	Average per dom. consumer, M cu. ft.	Average price ¢ per M cu. ft.
West Virginia	127,168	20,968,624	164.89	21.02
Pennsylvania	481,275	59,839,730	124.34	31.37
Ohio	885,876	98,023,666	110.65	32.36
Kentucky	90,849	7,922,941	87.21	30.98
Indiana	31,032	2,428,003	78.25	37.48
22 Other States	892,345	81,919,334	91.80	32.64
Total United States	2,508,543	271,102,298	108.07	31.35

PENNA. EX. 32—ANDERSON. 9/16/20. E. M.—*Continued.*

From Special Compilation Taken from Reports to Board of Public Works and the Public Service Commission of West Virginia.

Year.	No. dom. consumers.	Volume, M cu. ft.	Average per dom. consumer, M cu. ft.
W. Va. 1909	57,208	9,907,023	173.18
" 1910	71,900	11,173,508	155.40
" 1911	70,880	11,311,715	159.59
" 1912	74,985	13,288,159	177.21
" 1913	82,139	12,961,799	157.80
" 1914	88,344	14,265,209	161.47
" 1915	94,098	15,220,207	161.75
" 1916	109,216	15,237,221	139.51
" 1917	122,329	16,404,234	134.10
" 1918	125,341	19,618,873	156.52
" 1919	130,780	18,753,986	143.40

Name of utility.	No. of domestic consumers.	Volume, M cu. ft.	Average per dom. consumer, M cu. ft.
Charleston-Dunbar N. G. Co.	1,800	265,611	147.56
Clarksburg L. & H. Co.	8,282	1,528,243	184.53
Hope Natural Gas Co.	19,076	2,512,816	131.73
Huntington Dev. & Gas Co.	4,210	960,003	228.03
Mfg. L. & H. Co.	10,967	1,452,353	132.43
Monon. Valley Trac. Co.	6,114	890,622	145.67
Nat. Gas Co. of W. Va.	14,298	1,823,633	127.54
Pittsburgh & W. Va. Gas Co.	4,250	554,350	130.44
Randall Gas Co.	1,310	199,100	151.98
United Fuel Gas Co.	24,528	4,336,112	176.78
W. Va. Central Gas Co.	5,431	642,516	118.31
W. Va. & Md. Gas Co.	6,998	558,732	79.84
W. Va. Trac. & Elec. Co.	2,506	364,321	145.38
54 Other Utilities	21,010	2,665,674	126.88
Total W. Va.	130,780	18,753,986	143.40

PENNA. EX. 32—ANDERSON. 9/16/20. E. M.—*Continued.*

Average Price Do m. Gas Yr. 1918.

Charleston-Dunbar N. G. Co.	.....
Clarksburg L. & H. Co.	17.70
Hope Natural Gas Co.	20.06
Huntington Dev. & Gas Co.	15.93
Mfg. L. & H. Co.	26.95
Monon. Valley Trac. Co.	22.30
Nat. Gas Co. of W. Va.	30.51
Pittsburgh & W. Va. Gas Co.	22.15
Randall Gas Co.	16.77
United Fuel Gas Co.	16.52
W. Va. Central Gas Co.	25.80
W. Va. & Md. Gas Co.	33.10
W. Va. Trac. & Elec. Co.	20.40
54 Other Utilities	.....

PENNSYLVANIA EXHIBIT 33.

Offered at p. 824 of Printed Record by Witness Anderson.

Estimate of Monthly and Yearly Sales of Natural Gas in West Virginia.

149

PENNA. EX. 33—ANDERSON. 9/16/20. E. M.

Estimate of Maximum Monthly Sales in West Virginia.

Name of utility.	Domestic. Yr.	Mo.	M cu. ft.	Industrial. Yr.	Mo.	M cu. ft.	Commercial.	Total, M cu. ft
Clbg. L. & H. Co.	1918,	Jan.	305,000	1917,	May	545,000	....	850,000
Col. G. & E. Co.	1920,	Jan.	8,064	1920,	Jan.	69,164	....	77,228
Hope Nat. G. Co.*	1918,	Jan.	458,711	1917,	May	557,732	....	1,016,443
Hunt D. & G. Co.	1918,	Jan.	199,848	1918,	July	429,682	....	629,530
Imp. O. G. & P. Co.	1920,	Jan.	9,458	1913,	Mar.	170,300	....	179,758
Mfg. L. & H. Co.	1918,	Jan.	187,997	1915,	Dec.	505,994	....	693,991
Nat. G. Co. of W. Va.	1920,	Jan.	435,606	1912,	Sep.	148,374	....	583,980
Ptbg. & W. Va. G. Co.	1920,	Jan.	123,052	1918,	Nov.	368,891	....	491,943
Reserve Gas Co.*	1918,	Jan.	13,558	1917,	Nov.	12,653	....	26,211
United F. Gas Co.	1920,	Jan.	787,424	1918,	Nov.	631,953	....	1,419,377
W. Va. Cent. G. Co.	1918,	Jan.	324,000	1912,	Nov.	754,000	....	1,078,000
W. Va. T. & E. Co.(a)	1920,	Jan.	54,444	1920,	Jan.	81,831	6,718	142,993
Total			2,907,162			4,275,574	6,718	7,189,454

*Does not include gas used in drilling wells and in compressor stations.
(a) Now W. Va. Utilities Company.

Estimate of Yearly Sales of Natural Gas in the State of West Virginia on the Basis of Maximum Monthly Domestic and Industrial Sales.

(1) Name of utility.	(2) Total of maximum monthly dom. & ind. sales, M cu. ft.	(3) Est. yearly total of max. sales, M cu. ft.	(4) Actual total sales year 1919, M cu. ft.	Difference between columns 4 & 3, M cu. ft.
Clbg. L. & H. Co.	850,000	10,200,000	4,542,832	5,657,168
Columbia G. & E. Co.	77,228	926,736	82,364	844,372
Hope Nat. Gas Co.	1,016,443	12,197,316	4,930,212*	7,267,104
Hunt. Dev. & Gas Co.	629,530	7,554,360	4,741,583	2,812,777
Imp. O. & G. P. Co.	179,758	2,157,096	137,578	2,019,518
Mfg. L. & H. Co.	693,991	8,327,892	5,394,317	2,933,575
Nat. Gas Co. of W. Va.	583,980	7,007,760	2,923,345	4,084,415
Pittsburgh & W. Va. G. Co.	491,943	5,903,316	3,100,012	2,803,304
Reserve Gas Co.	26,211	314,532	78,429*	236,103
United Fuel G. Co.	1,419,377	17,032,524	11,323,038	5,709,486
West Va. Cent. Gas Co.	1,078,000	12,936,000	1,034,043	11,901,957
W. Va. Trac. & E. Co.	142,993	1,715,916	1,334,471	381,445
Total	7,189,454	86,273,448	39,622,224	46,651,224

Total sales in the State of W. Va. year 1919 from reports to Bd. of Public Works	83,769,937	M. cu. ft.
Total actual Domestic & Industrial sales of above Companies year 1919	39,622,224	"
% of actual sales of 12 companies to total sales	47.3%	
Est. Increase on this basis	98,628,380	

*From Form 56 E-P. S. C. W. Va.

Estimate of Yearly Sales of Natural Gas in the State of W. Va. on the Basis of Maximum Industrial and Actual Domestic Sales.

(1) Name of utility	(2) Actual domestic sales year. M cu. ft.	(3) Est. y'rly total of max. ind. sales, M cu. ft.	(4) Est. total of possible actual sales, M cu. ft.	(5) Actual total sales year 1919, M cu. ft.	(6) Difference between columns 4 or 5, M cu. ft.
Clarksbg. L. & H. Co.	1,528,243	6,540,000	8,068,243	4,542,832	.....
Columbia Gas & E. Co.	35,133	829,968	865,101	82,364	.....
Hope Nat. Gas Co.	2,512,816	6,692,784	9,205,600	*4,930,212	.....
Hunt. Dev. & Gas Co.	960,003	5,156,184	6,116,187	4,741,583	.....
Imperial Oil & Gas Pro. Co.	50,638	2,043,600	2,094,238	137,578	.....
Mfgrs. L. & H. Co.	1,452,353	6,071,928	7,524,281	5,394,317	.....
Nat. Gas Co. of W. Va.	1,823,633	1,780,488	3,604,121	2,923,345	.....
Pittsbrg. & W. Va. Gas Co.	554,350	4,426,692	4,981,042	3,100,012	.....
Reserve Gas Co.	78,429	151,836	230,265	*78,429	.....
United Fuel & Gas Co.	4,336,112	7,583,436	11,919,548	11,323,038	.....
W. Va. Central Gas Co.	642,516	9,048,000	9,690,516	1,034,043	.....
W. Va. Traction & E. Co.	364,321	981,972	1,346,293	1,334,471	.....
Total	14,338,547	51,306,888	65,645,435	39,622,224	26,023,211

Total Sales in the State of W. Va. year 1919 from Reports of Bd. of Public Works	83,769,937	M cu. ft.
Total Actual Domestic & Industrial Sales of above companies, year 1919	39,622,224	M cu. ft.
% of Actual Sales of 12 companies to total sales	47.3%	
Estimated annual increased demand on this basis	55,017,359	M cu ft.

*From Form No. 56 E-P. S. C. W. Va.

151*a* PENNSYLVANIA EXHIBIT 34.

Offered at p. 825 of Printed Record by Witness Anderson.

Comparison of Maximum Yearly Consumption of Natural Gas for Industrial Consumers in the State of West Virginia for Years 1915 *to* 1919, *Inclusive, with Year* 1918.

152 PENNA. EX. 34—ANDERSON. 9/16/20. E. N.

Summary of Comparison of Maximum Yearly Consumption of Natural Gas for Industrial Consumers in the State of West Virginia for the Years 1915 *to* 1919, *Inclusive, with the Year* 1918.

	M cubic feet.	
	Maximum, 1915-1918.	1918.
Bridgeport Natural Gas & Oil Co.	101,270	55,940
Clarksburg Ligh- and Heat Co.	5,306,147	3,586,065
Hope Natural Gas Company	5,223,068	4,017,808
Manufacturers Gas & Elec. Light Co.	106,105	66,102
Manufacturers Light & Heat Co.	5,003,541	3,561,411
Natural Gas Co. of W. Va.	765,953	728,265
Northern Natural Gas Co.	4,699	4,572
Pittsburgh & W. Va. Gas Co.	2,589,159	1,987,470
Raccoon Gas Company	737,453	232,332
Randall Gas Company	747,648	486,372
Reserve Gas Company	9,852	2,943
United Fuel Gas Company	5,441,475	4,910,200
W. Va. Central Gas Co.	735,692	277,556
W. Va. & Md. Gas Company	1,284,170	69,587
W. Va. Utilities Company	1,680,966	684,946
	29,737,208	20,671,569

Percentage increase of Maximum 1915-1918 to yr. 1918.. 43.86%
Total industrial consumption year 1918 in the State of W. Va. (U. S. G. S.) ..... 87,704,820 M cu. ft.
Estimated total increase of W. Va. ..... 38,467,334 "

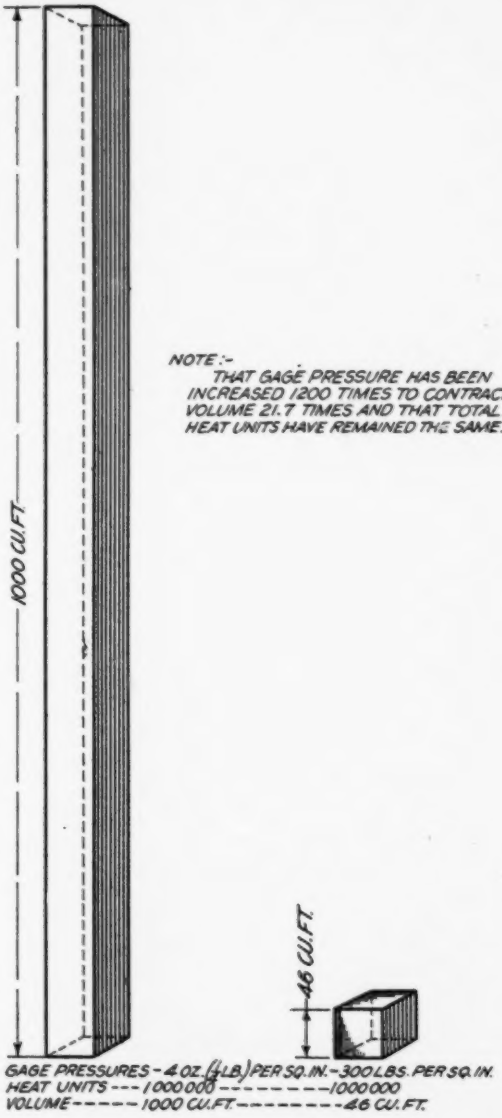
(It is to be noted that these figures are based principally on records for only four years.)

DIAGRAM SHOWING HOW A GIVEN AMOUNT OF GAS CAN BE CONTRACTED BY THE APPLICATION OF PRESSURE

153 PENNSYLVANIA EXHIBIT 35.

Offered at p. 867 of Printed Record by Witness Wyer.

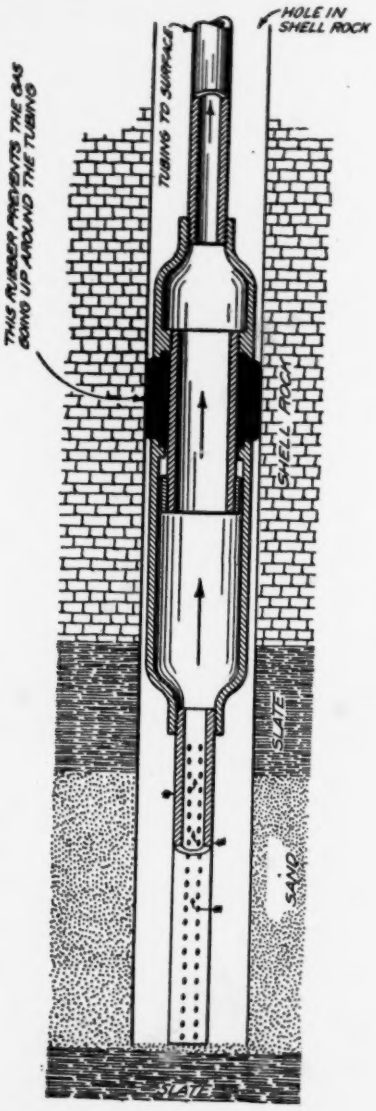
Diagram Showing How a Given Amount of Gas Can Be Contracted by Application of Pressure.


1000 CU.FT.
NOTE:-
THAT GAGE PRESSURE HAS BEEN INCREASED 1200 TIMES TO CONTRACT VOLUME 21.7 TIMES AND THAT TOTAL HEAT UNITS HAVE REMAINED THE SAME.
46 CU.FT.
GAGE PRESSURES - 4 OZ. (¼ LB.) PER SQ. IN. - 300 LBS. PER SQ. IN.
HEAT UNITS --- 1000000 --------- 1000000
VOLUME ----- 1000 CU.FT. --------- 46 CU.FT.

HOW NATURAL GAS IS SEVERED FROM TH
AND DELIVERED INTO A FIXE

FIRST STEP

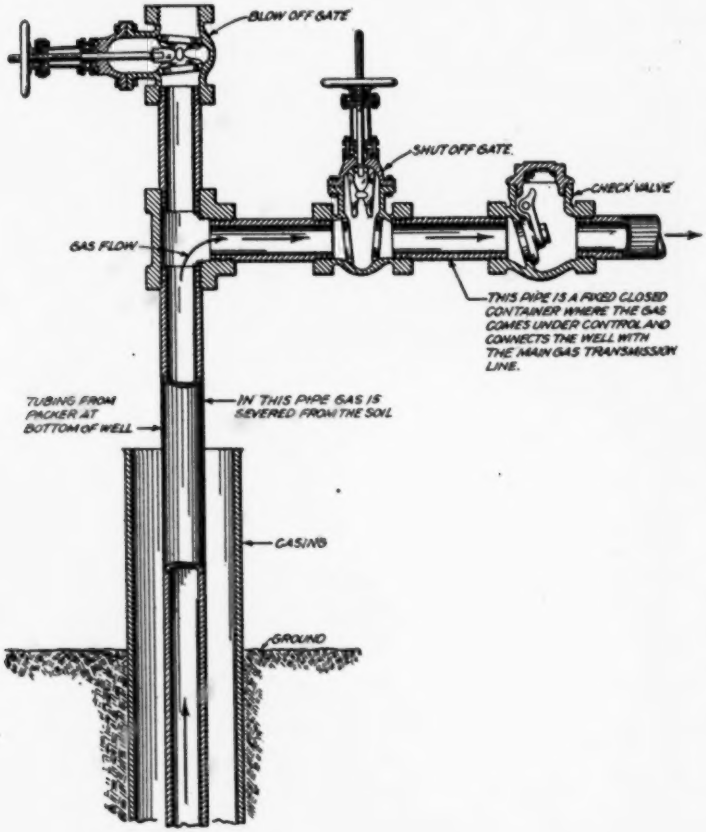
Well packer at bottom of well—usually about ½ mile below the earth's surface—where the gas is separated from the ground, is forced into the tubing, and then comes to the surface.



THE SOIL. BROUGHT UNDER CONTROL,
FIXED CLOSED CONTAINER

FINAL STEP

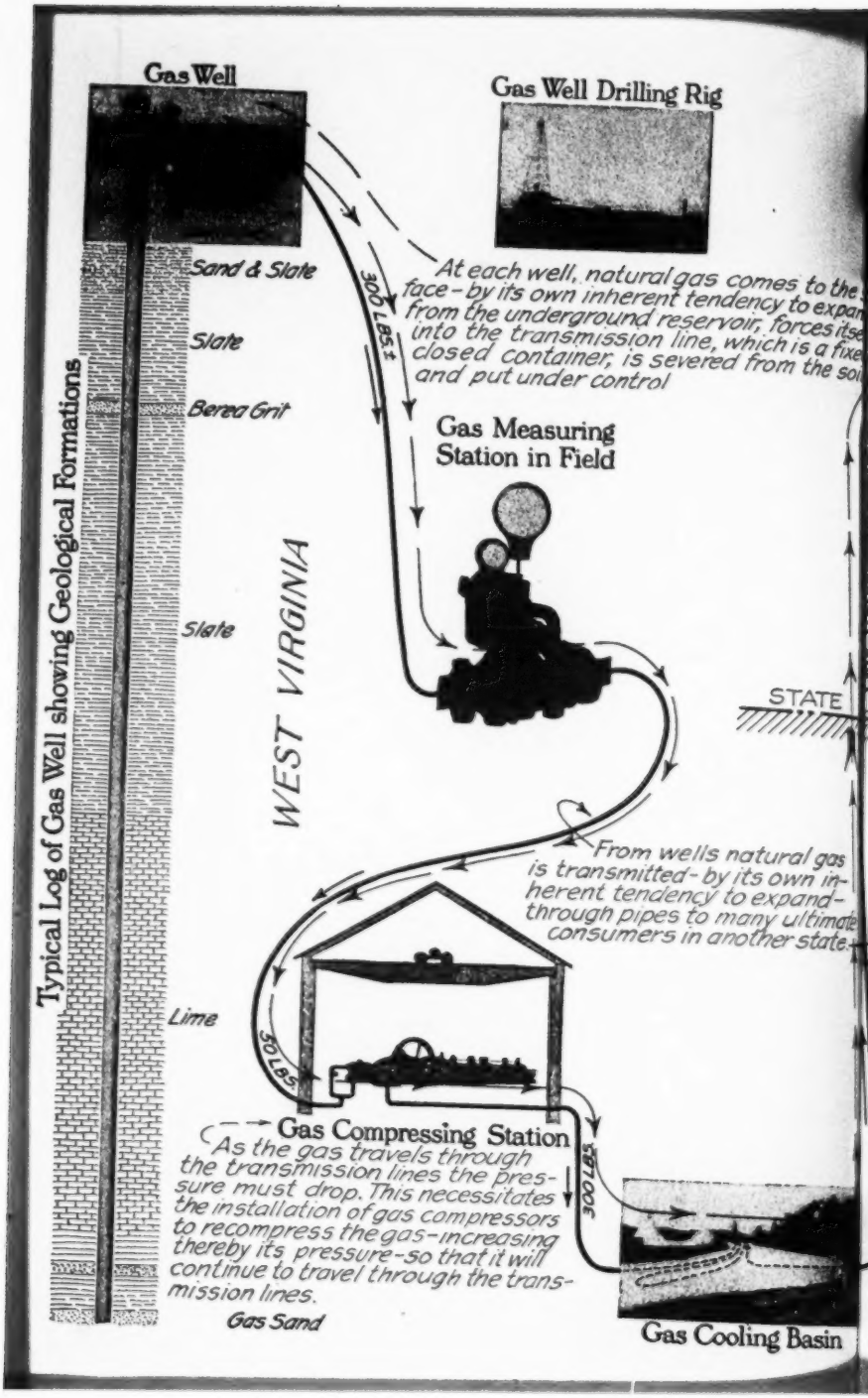
Well fittings above ground where the gas from the packer below as it flows up through the tubing comes under control and is delivered into the well discharge line which is a fixed closed container.

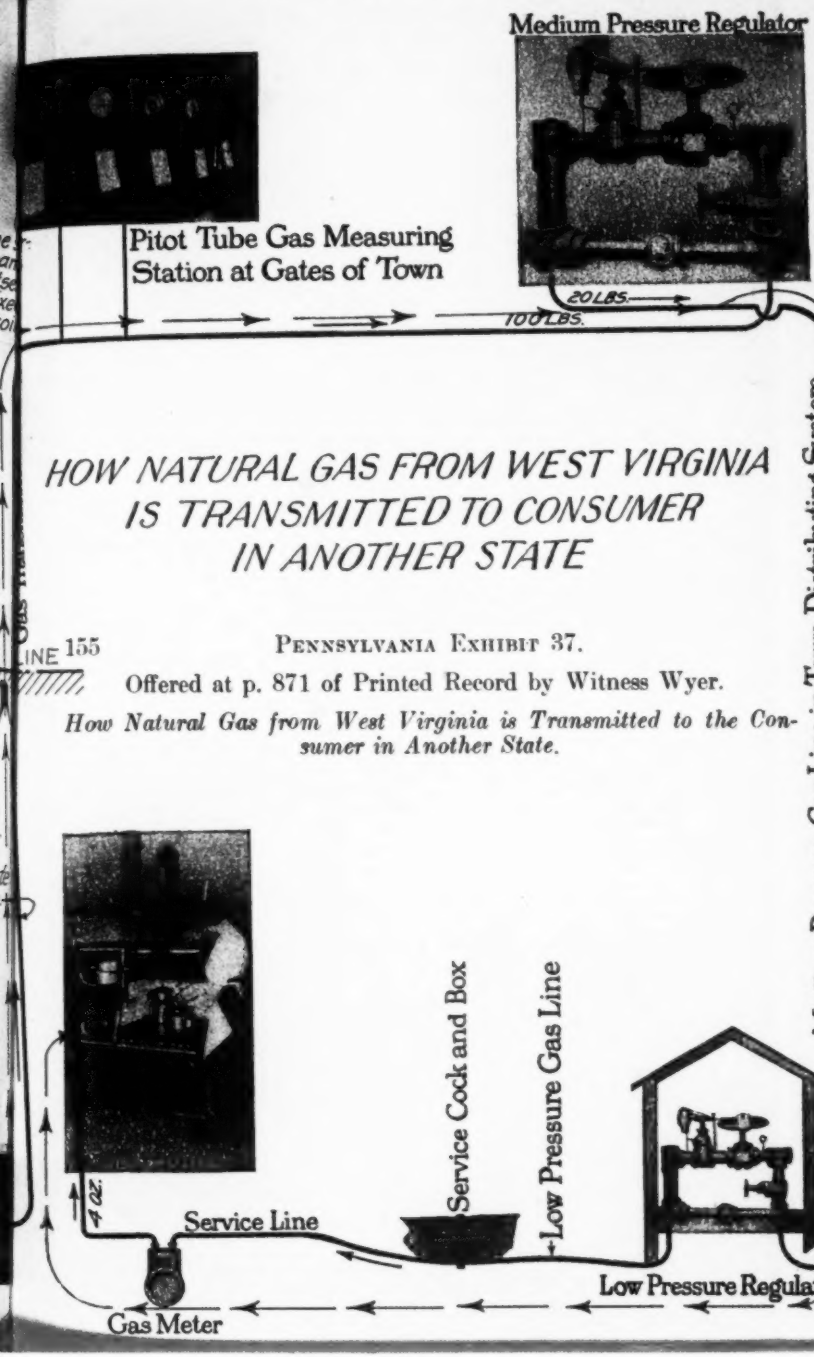

BLOW OFF GATE
SHUT OFF GATE
CHECK VALVE
GAS FLOW
THIS PIPE IS A FIXED CLOSED CONTAINER WHERE THE GAS COMES UNDER CONTROL AND CONNECTS THE WELL WITH THE MAIN GAS TRANSMISSION LINE.
TUBING FROM PACKER AT BOTTOM OF WELL
IN THIS PIPE GAS IS SEVERED FROM THE SOIL
CASING
GROUND

154 PENNSYLVANIA EXHIBIT 36.

Offered at p. 870 of Printed Record by Witness Wyer.

How Natural Gas is Severed from the Soil, Brought under Control, and Delivered Into a Fixed Closed Container.


Gas Well
Gas Well Drilling Rig
Sand & Slate
Slate
Berea Grit
Slate
Lime
Gas Sand
Typical Log of Gas Well showing Geological Formations
WEST VIRGINIA
300 LBS±
At each well, natural gas comes to the face - by its own inherent tendency to expan from the underground reservoir, forces itse into the transmission line, which is a fixe closed container, is severed from the soi and put under control
Gas Measuring Station in Field
STATE
From wells natural gas is transmitted - by its own in- herent tendency to expand - through pipes to many ultimate consumers in another state
300 LBS
Gas Compressing Station
As the gas travels through the transmission lines the pres- sure must drop. This necessitates the installation of gas compressors to recompress the gas - increasing thereby its pressure - so that it will continue to travel through the trans- mission lines.
300 LBS
Gas Cooling Basin


Medium Pressure Regulator
Pitot Tube Gas Measuring Station at Gates of Town
20 LBS.
100 LBS.
HOW NATURAL GAS FROM WEST VIRGINIA IS TRANSMITTED TO CONSUMER IN ANOTHER STATE
Medium Pressure Gas Line in Town Distributing System
4 OZ.
Service Line
Service Cock and Box
Low Pressure Gas Line
15 LBS.
Low Pressure Regulator
Gas Meter

LINE 155

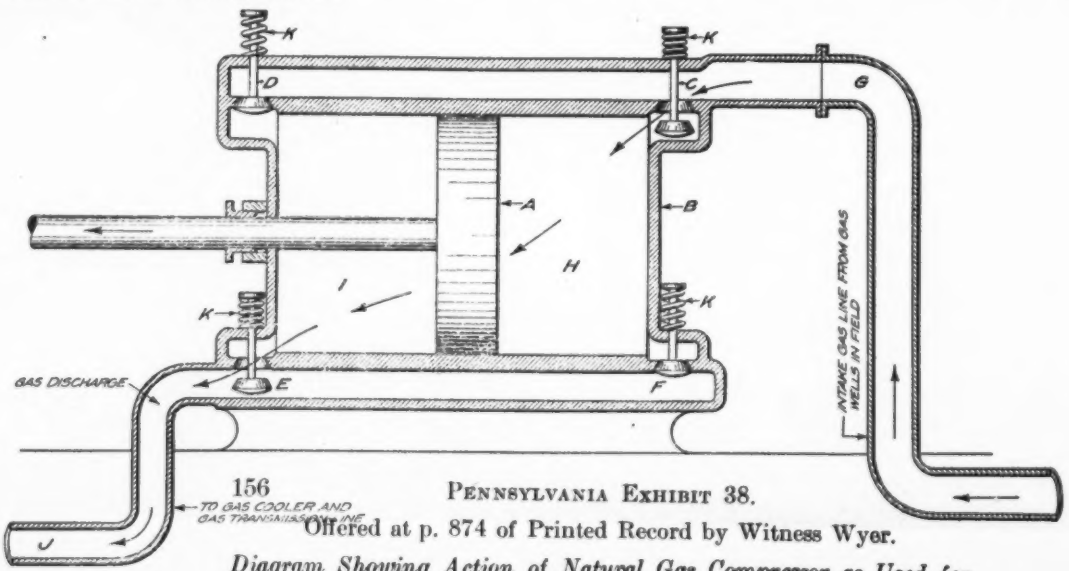
PENNSYLVANIA EXHIBIT 37.

Offered at p. 871 of Printed Record by Witness Wyer.

How Natural Gas from West Virginia is Transmitted to the Consumer in Another State.

DIAGRAM SHOWING ACTION OF NATURAL GAS COMPRESSOR AS USED FOR COMPRESSING GAS FOR TRANSMISSION THROUGH LINES

The action of a gas compressor is illustrated in the diagram below, where A is a reciprocating piston working in cylinder B. C and D are inlet valves to the cylinder, and E and F are discharge valves to the cylinder, drawn to their seats by the springs K K. All the gas wells are connected to the intake side of a compressor so that the pressure from the wells drives the gas to the compressor. As the piston moves in the direction of the arrow the inlet valve C is opened by the higher pressure of the gas in the intake G, and the gas then rushes from G through C into the space H. As the piston moves toward the end of its stroke the gas in space I is forced out into the discharge line J through the discharge valve E. When the piston A reaches the end of its stroke the spring K closes the valve C and on its return stroke the piston A compresses the gas in H until the pressure is great enough to open the discharge valve F and thereby drive the gas out into the discharge line J.



156 PENNSYLVANIA EXHIBIT 38.

Offered at p. 874 of Printed Record by Witness Wyer.

Diagram Showing Action of Natural Gas Compressor as Used for Compressing Gas Through Transmission Lines.

7

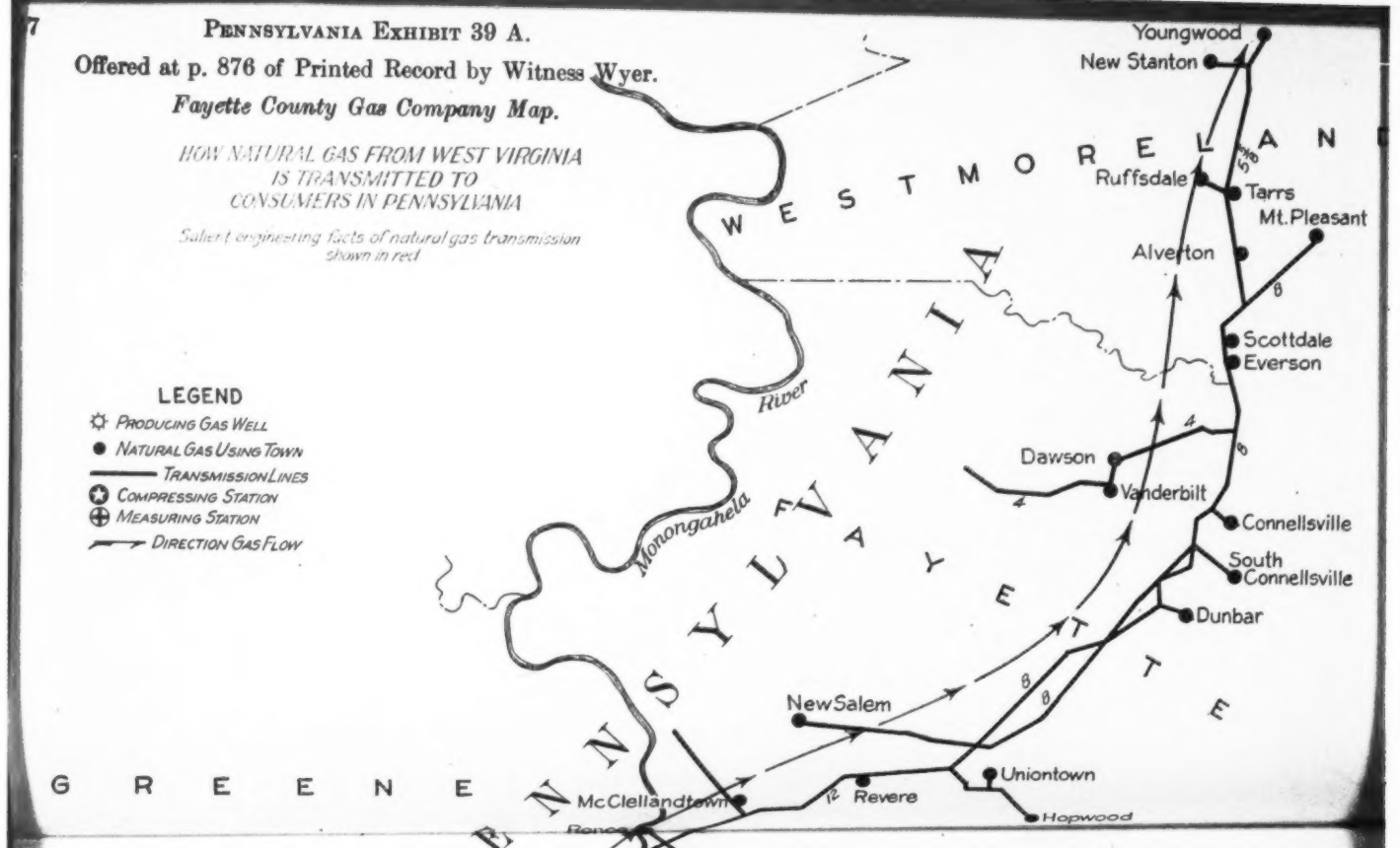
PENNSYLVANIA EXHIBIT 39 A.

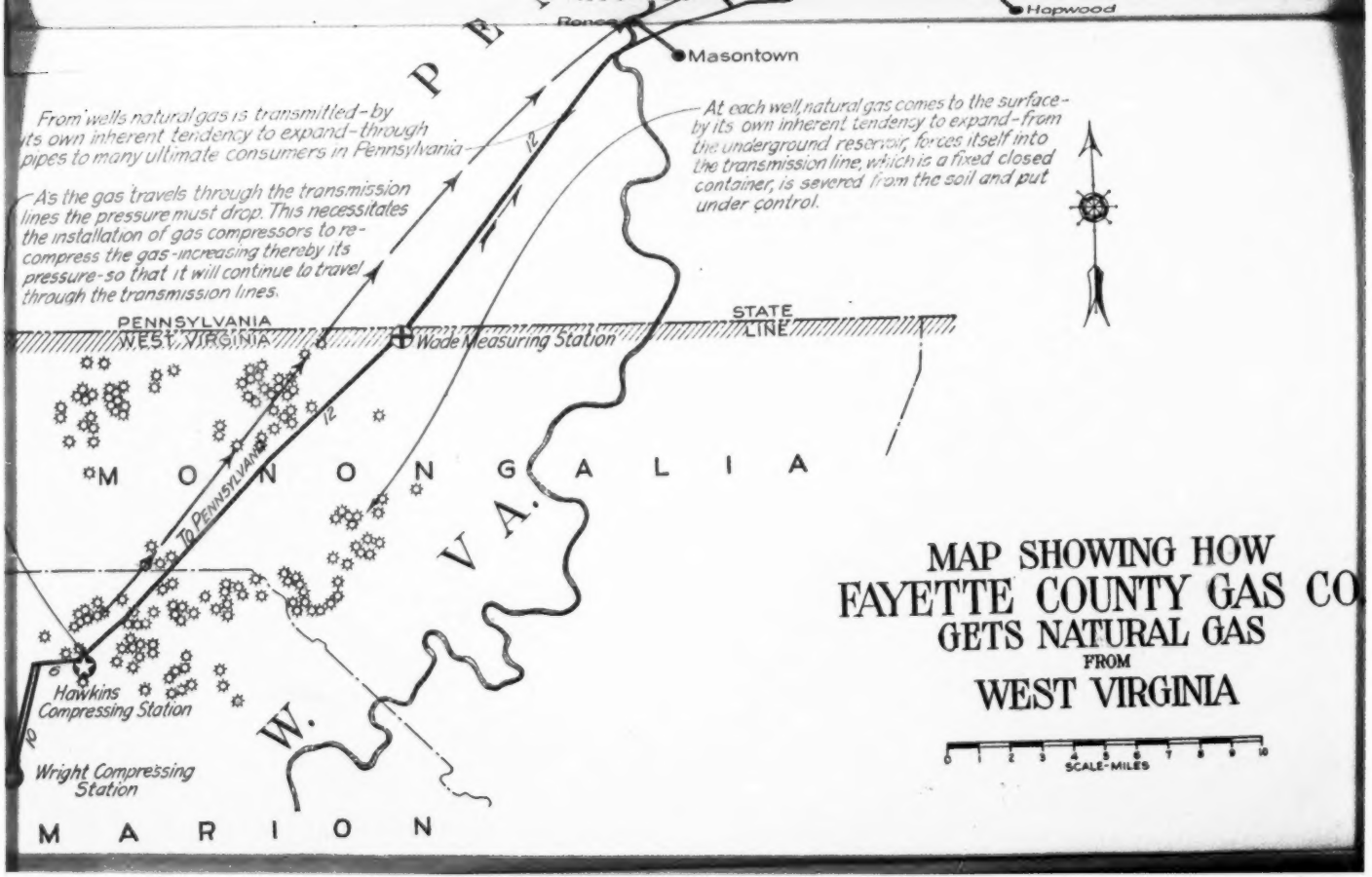
Offered at p. 876 of Printed Record by Witness Wyer.

Fayette County Gas Company Map.

HOW NATURAL GAS FROM WEST VIRGINIA IS TRANSMITTED TO CONSUMERS IN PENNSYLVANIA

Salient engineering facts of natural gas transmission shown in red




Hopwood
Masontown
From wells natural gas is transmitted - by its own inherent tendency to expand - through pipes to many ultimate consumers in Pennsylvania
As the gas travels through the transmission lines the pressure must drop. This necessitates the installation of gas compressors to re-compress the gas - increasing thereby its pressure - so that it will continue to travel through the transmission lines.
At each well, natural gas comes to the surface - by its own inherent tendency to expand - from the underground reservoir, forces itself into the transmission line, which is a fixed closed container, is severed from the soil and put under control.
PENNSYLVANIA
WEST VIRGINIA
STATE LINE
Wade Measuring Station
To Pennsylvania
M O N O N G A L I A
W. VA.
Hawkins Compressing Station
Wright Compressing Station
M A R I O N
MAP SHOWING HOW
FAYETTE COUNTY GAS CO
GETS NATURAL GAS
FROM
WEST VIRGINIA
0 1 2 3 4 5 6 7 8 9 10
SCALE-MILES

PENNSYLVANIA EXHIBIT 39 B.

Offered at p. 876 of Printed Record by Witness Wyer.

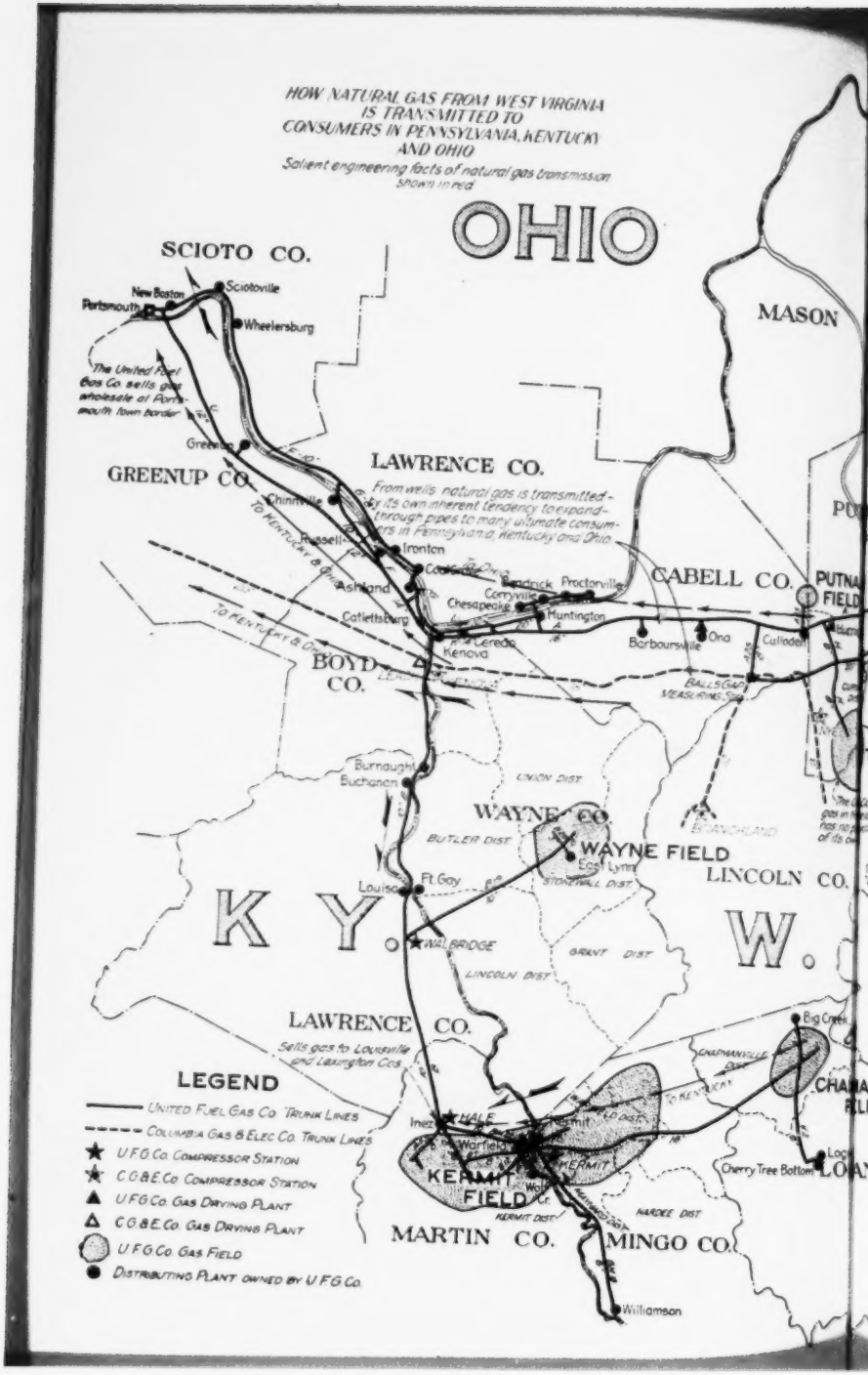
Hope Natural Gas Company Map.

159 PENNSYLVANIA EXHIBIT 39 C.

Offered at p. 876 of Printed Record by Witness Wyer.

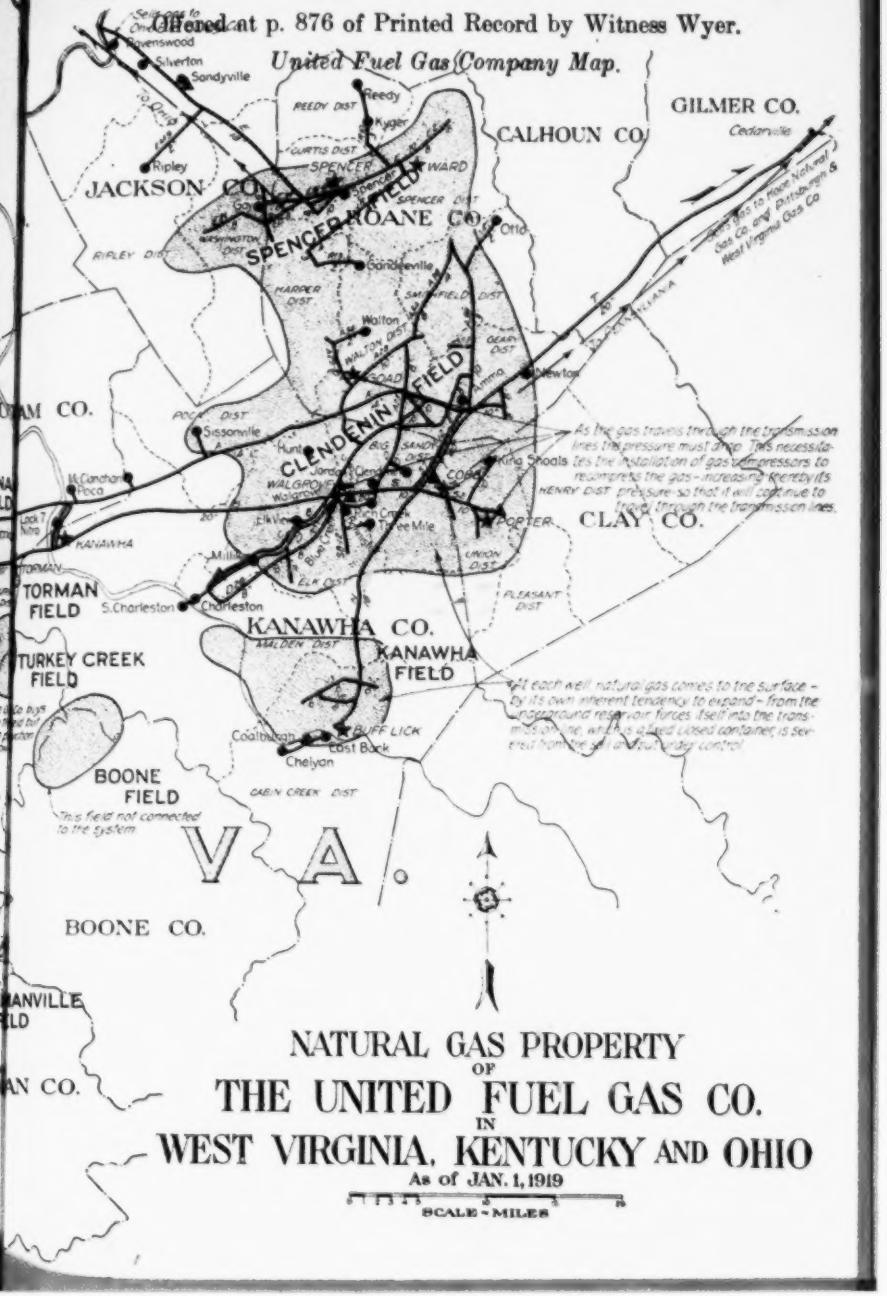
Reserve Natural Gas Company Map.

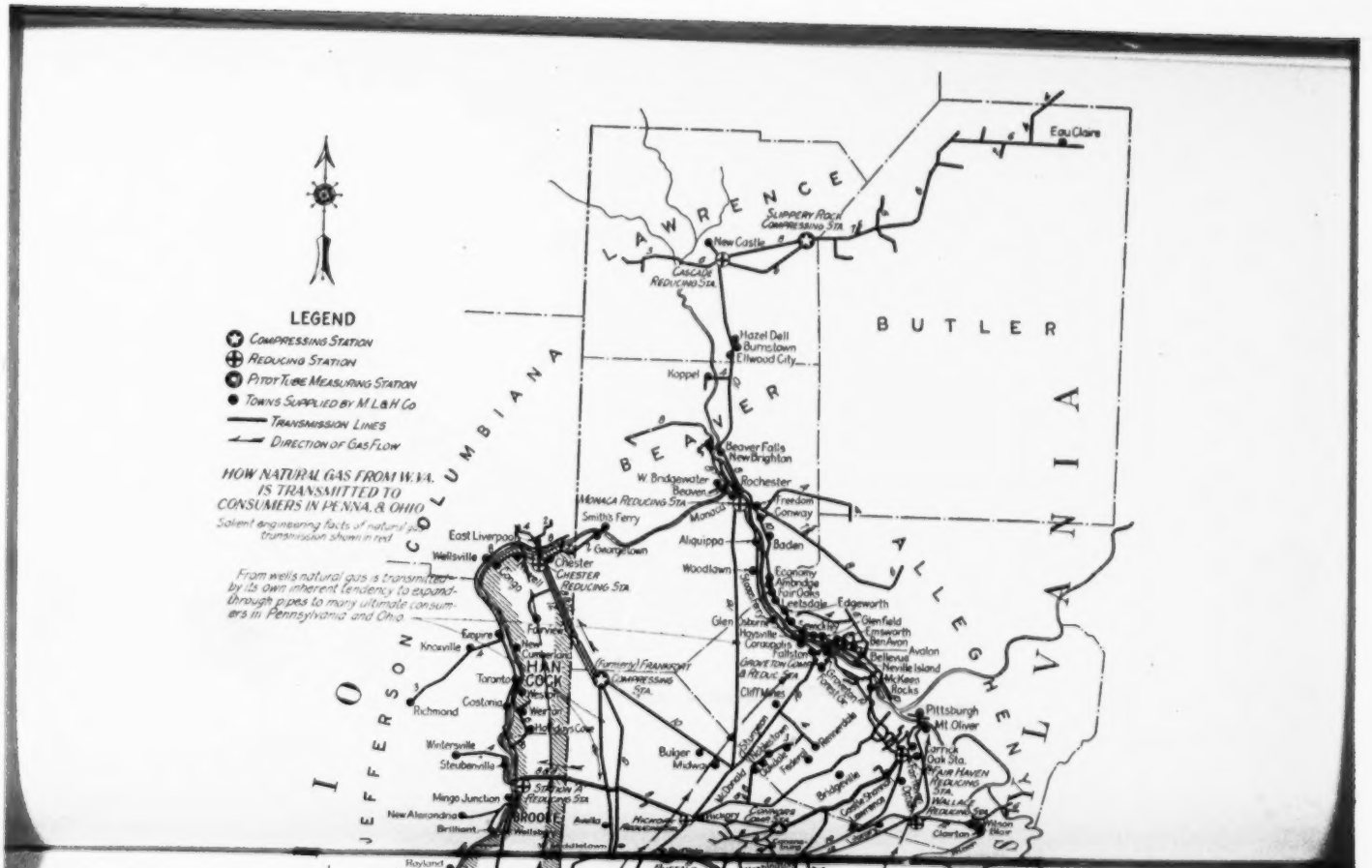
HOW NATURAL GAS FROM WEST VIRGINIA IS TRANSMITTED TO CONSUMERS IN OHIO & INDIANA
Salient engineering facts of natural gas transmission shown in red
LEGEND
COMPRESSING STATION
MEASURING STATION
DIRECTION OF GAS FLOW
PENNSYLVANIA STATE LINE
WEST VIRGINIA
Note
The towns of Camden and Wilsonburg are supplied by Reserve Gas Company
OHIO
Ohio River
TYLER
PLEASANTS
To Connecting Gas Co.
To Ohio & Indiana
WOOD
DODDRIDGE
HARRISON
WEST VIRGINIA
Wilsonburg
WILSONBURG COMPRESSING STA.
CORRIN COMPRESSING STA.
RITCHIE
From wells natural gas is transmitted by its own inherent tendency to expand through pipes to many ultimate consumers in Ohio and Indiana
Dry Fork
KENNEDY COMPRESSING STA.
CAMDEN COMPRESSING STA.
Camden
GILMER
LEWIS
At each well, natural gas comes to the surface by its own inherent tendency to expand - from the underground reservoir, flows itself into the transmission line, which is a fixed closed container, is severed from the soil and put under control
MAP OF MAIN LINES OF RESERVE GAS COMPANY IN WEST VIRGINIA
SCALE 15 MILES


HOW NATURAL GAS FROM WEST VIRGINIA IS TRANSMITTED TO CONSUMERS IN PENNSYLVANIA, KENTUCKY AND OHIO
Salient engineering facts of natural gas transmission shown in red
OHIO
SCIOTO CO.
New Boston
Portsmouth
Sciotoville
Wheelersburg
The United Fuel Gas Co. sells gas wholesale at Portsmouth town border
Greenup
GREENUP CO.
LAWRENCE CO.
From wells natural gas is transmitted by its own inherent tendency to expand through pipes to many ultimate consumers in Pennsylvania, Kentucky and Ohio
Chinnville
Russell
Ironton
To Kentucky & Ohio
Ashland
Coalgate
Catlettsburg
To Kentucky & Ohio
Chesapeake
Cerryville
Proctorville
Huntington
CABELL CO.
PUTNAM FIELD
Barboursville
Ona
Culloden
Kenova
BOYD CO.
BALLSGAP MEASURING STA.
Burnaugh
Buchanan
UNION DIST.
WAYNE CO.
BUTLER DIST.
WAYNE FIELD
East Lynn
STONEWALL DIST.
LINCOLN CO.
Louisa
Ft. Gay
K Y
W. Va.
WAL BRIDGE
GRANT DIST.
LINCOLN DIST.
LAWRENCE CO.
Sells gas to Louisville and Lexington Cos.
Big Creek
CHAPMANVILLE DIST.
CHAPMANVILLE FIELD
TO KENTUCKY
Inez
HALE
Warfield
Kermit
KERMIT
KERMIT FIELD
KERMIT DIST.
Cherry Tree Bottom
LOGAN
HARDEE DIST.
MARTIN CO.
MINGO CO.
Williamson
LEGEND
United Fuel Gas Co. Trunk Lines
Columbia Gas & Elec. Co. Trunk Lines
U.F.G. Co. Compressor Station
C.G.&E. Co. Compressor Station
U.F.G. Co. Gas Drying Plant
C.G.&E. Co. Gas Drying Plant
U.F.G. Co. Gas Field
Distributing Plant owned by U.F.G. Co.

160 PENNSYLVANIA EXHIBIT 39 D.

Offered at p. 876 of Printed Record by Witness Wyer.

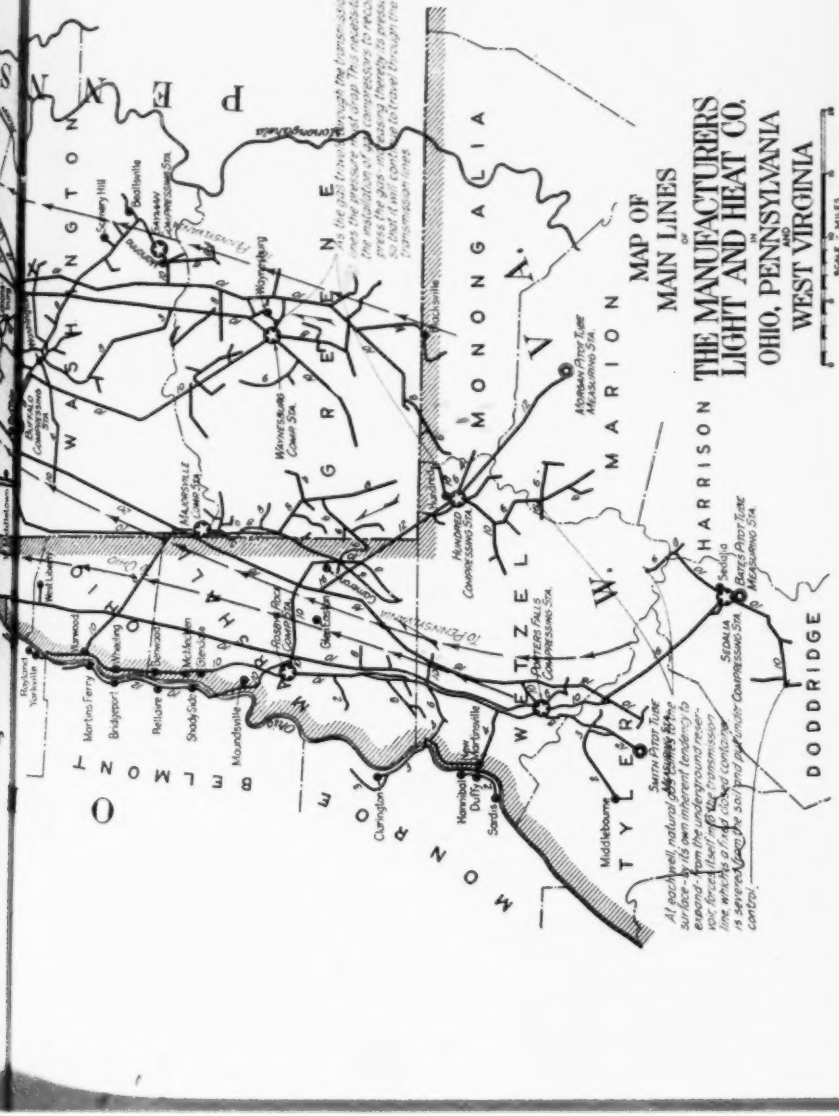



LEGEND
COMPRESSING STATION
REDUCING STATION
PITOT TUBE MEASURING STATION
TOWNS SUPPLIED BY M L & H CO
TRANSMISSION LINES
DIRECTION OF GAS FLOW
HOW NATURAL GAS FROM W.VA. IS TRANSMITTED TO CONSUMERS IN PENNA. & OHIO
Salient engineering facts of natural gas transmission shown in red
From wells natural gas is transmitted by its own inherent tendency to expand through pipes to many ultimate consumers in Pennsylvania and Ohio
LAWRENCE
BUTLER
BEAVER
ALLEGHENY
JEFFERSON
COLUMBIANA
HANCOCK
BROOKE
Erie
Eau Claire
Slippery Rock Compressing Sta.
New Castle
Cascade Reducing Sta.
Hazel Dell
Burnstown
Ellwood City
Koppel
Beaver Falls
New Brighton
W. Bridgewater
Beaver
Rochester
Monaca Reducing Sta.
Monaca
Freedom
Conway
Smiths Ferry
East Liverpool
Wellsville
Chester
Chester Reducing Sta.
Aliquippa
Baden
Woodlawn
Economy
Ambridge
Fair Oaks
Leetsdale
Edgeworth
Glenfield
Emsworth
Ben Avon
Avalon
Bellevue
Neville Island
McKeen Rocks
Pittsburgh
Mt Oliver
Carnegie
Oak Sta.
Aur Haven Reducing Sta.
Wallace Reducing Sta.
Clairton
Mason Dixon
Fairview
Knoxville
New Cumberland
Formerly Frankfort Compressing Sta.
Toronto
Richmond
Costonia
Weirton
Hollidays Cove
Wintersville
Steubenville
Bulger
Midway
Mingo Junction
Station A Reducing Sta.
New Alexandria
Brilliant
Avella
Wellsburg
Middletown
Rayland
Cadiz
Cadiz Junction
Hopedale
Scio
Bergholz
Irondale
Mingo
Brownsville
Centerville
Monongahela
Donora
Webster
Charleroi
Belle Vernon
Fayette City
Perryopolis
Uniontown
Connellsville
Dunbar
Normalville
Mt Pleasant
Scottdale
Jacobs Creek
Greensburg
Irwin
Export
Delmont
Murrysville
Penn
Harrison City
Parnassus
Lower Burrell
Arnold
Tarentum
Brackenridge
Natrona
Cheswick
Springdale
Aspinwall
Fox Chapel
Sharpsburg
Etna
Millvale
Reserve
Shaler
Ross
Bellevue
Avalon
Neville Island
McKeen Rocks
Glen Osborne
Haysville
Coraopolis
Fallston
Cliff Mine
Great Dow Chemical & Prod. Sta.
Bridgeville
Carnegie
Oak Sta.
Aur Haven Reducing Sta.
Wallace Reducing Sta.
Clairton
Mason Dixon

161 PENNSYLVANIA EXHIBIT 39 E.

Offered at p. 876 of Printed Record by Witness Wyer.

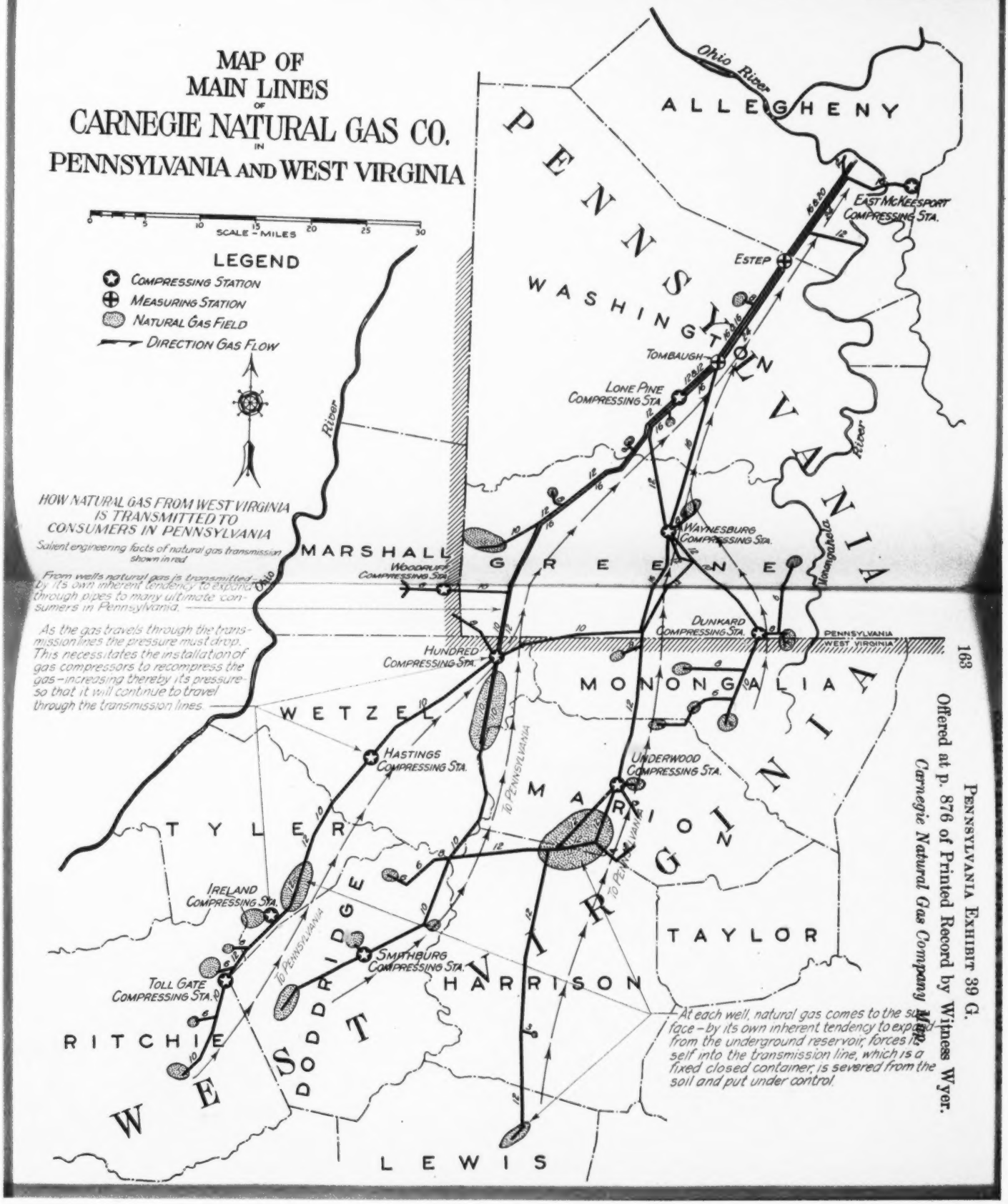
Manufacturers Light & Heat Company Map.


MAP OF MAIN LINES OF THE MANUFACTURERS LIGHT AND HEAT CO. IN OHIO, PENNSYLVANIA AND WEST VIRGINIA
SCALE 20 MILES
PENNSYLVANIA
WASHINGTON
GREENE
MONONGALIA
MARION
HARRISON
TYLER
WETZEL
MARSHALL
OHIO
BELMONT
MONROE
DODDRIDGE
Waynesburg
Mt. Morris
Deadlville
Mt. Pleasant
Compressing Sta.
Mannington
Monongah Prop. Tube Measuring Sta.
Hundred Compressing Sta.
Fairmont
Morgantown
Waynesburg Court Sta.
Fairchance
Masontown
Point Marion
Fairmont Compressing Sta.
Fairmont Prop. Tube Measuring Sta.
Smithfield
Fairmont Prop. Tube Measuring Sta.
Fairmont Compressing Sta.

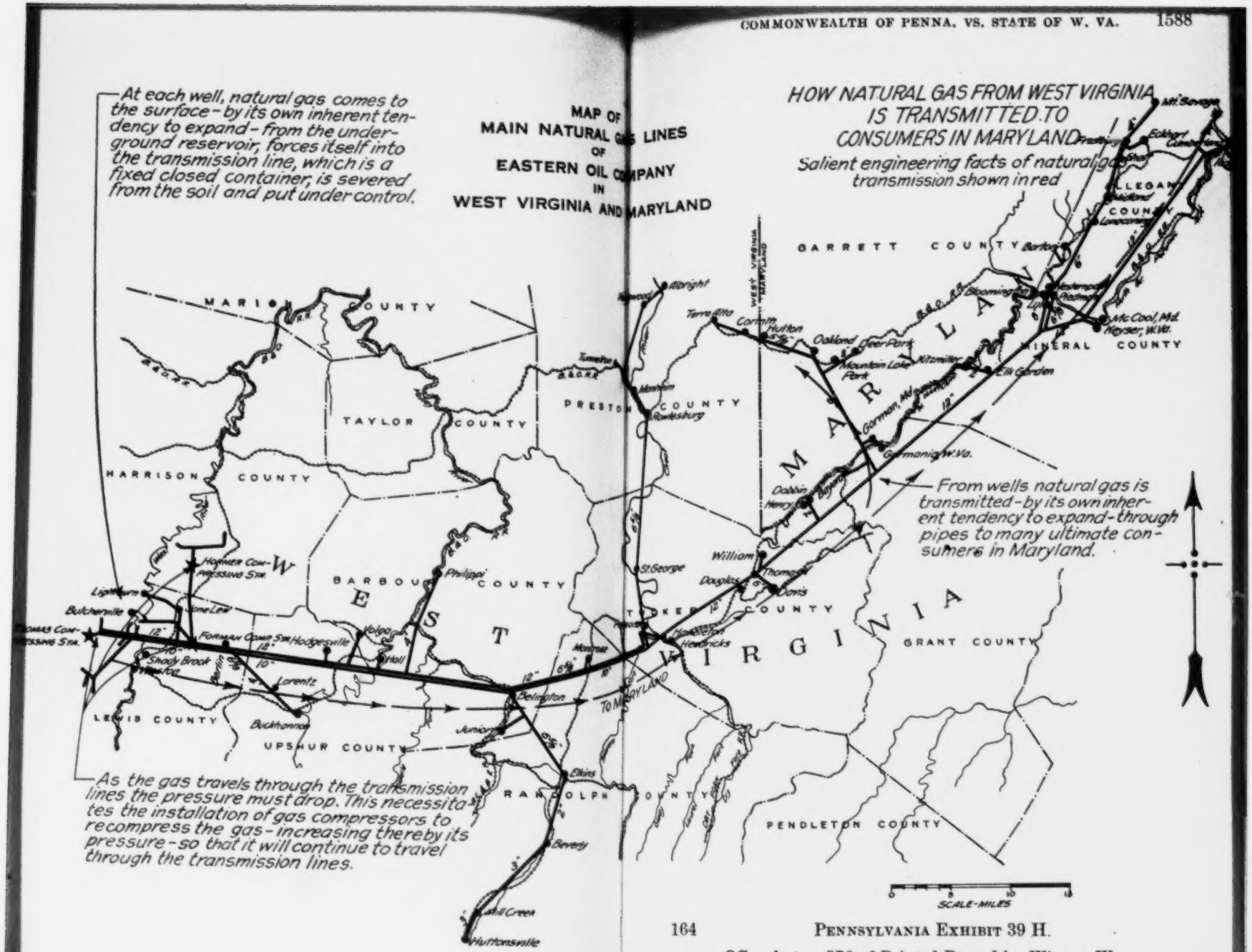
162 PENNSYLVANIA EXHIBIT 39 F.

Offered at p. 876 of Printed Record by Witness Wyer.

Philadelphia Company Map.


MAP OF
MAIN LINES
OF
CARNEGIE NATURAL GAS CO.
IN
PENNSYLVANIA AND WEST VIRGINIA
SCALE - MILES
LEGEND
COMPRESSING STATION
MEASURING STATION
NATURAL GAS FIELD
DIRECTION GAS FLOW
HOW NATURAL GAS FROM WEST VIRGINIA IS TRANSMITTED TO CONSUMERS IN PENNSYLVANIA
Salient engineering facts of natural gas transmission shown in red
From wells natural gas is transmitted by its own inherent tendency to expand through pipes to many ultimate consumers in Pennsylvania.
As the gas travels through the transmission lines the pressure must drop. This necessitates the installation of gas compressors to recompress the gas—increasing thereby its pressure so that it will continue to travel through the transmission lines.
At each well, natural gas comes to the surface—by its own inherent tendency to expand from the underground reservoir, forces itself into the transmission line, which is a fixed closed container, is severed from the soil and put under control.
Ohio River
ALLEGHENY
PENNSYLVANIA
WASHINGTON
EAST McKEESPORT COMPRESSING STA.
ESTEP
TOMBAUGH
LONE PINE COMPRESSING STA.
WAYNESBURG COMPRESSING STA.
Monongahela River
MARSHALL
GREENE
WOODRUFF COMPRESSING STA.
DUNKARD COMPRESSING STA.
PENNSYLVANIA
WEST VIRGINIA
HUNDRED COMPRESSING STA.
MONONGALIA
WETZEL
HASTINGS COMPRESSING STA.
UNDERWOOD COMPRESSING STA.
MARION
TYLER
IRELAND COMPRESSING STA.
TO PENNSYLVANIA
TAYLOR
SMITHBURG COMPRESSING STA.
TOLL GATE COMPRESSING STA.
HARRISON
RITCHIE
DODDRIDGE
WEST VIRGINIA
LEWIS

Pennsylvania Exhibit 39 G.
Offered at p. 876 of Printed Record by Witness Wyer.
Carnegie Natural Gas Company Map

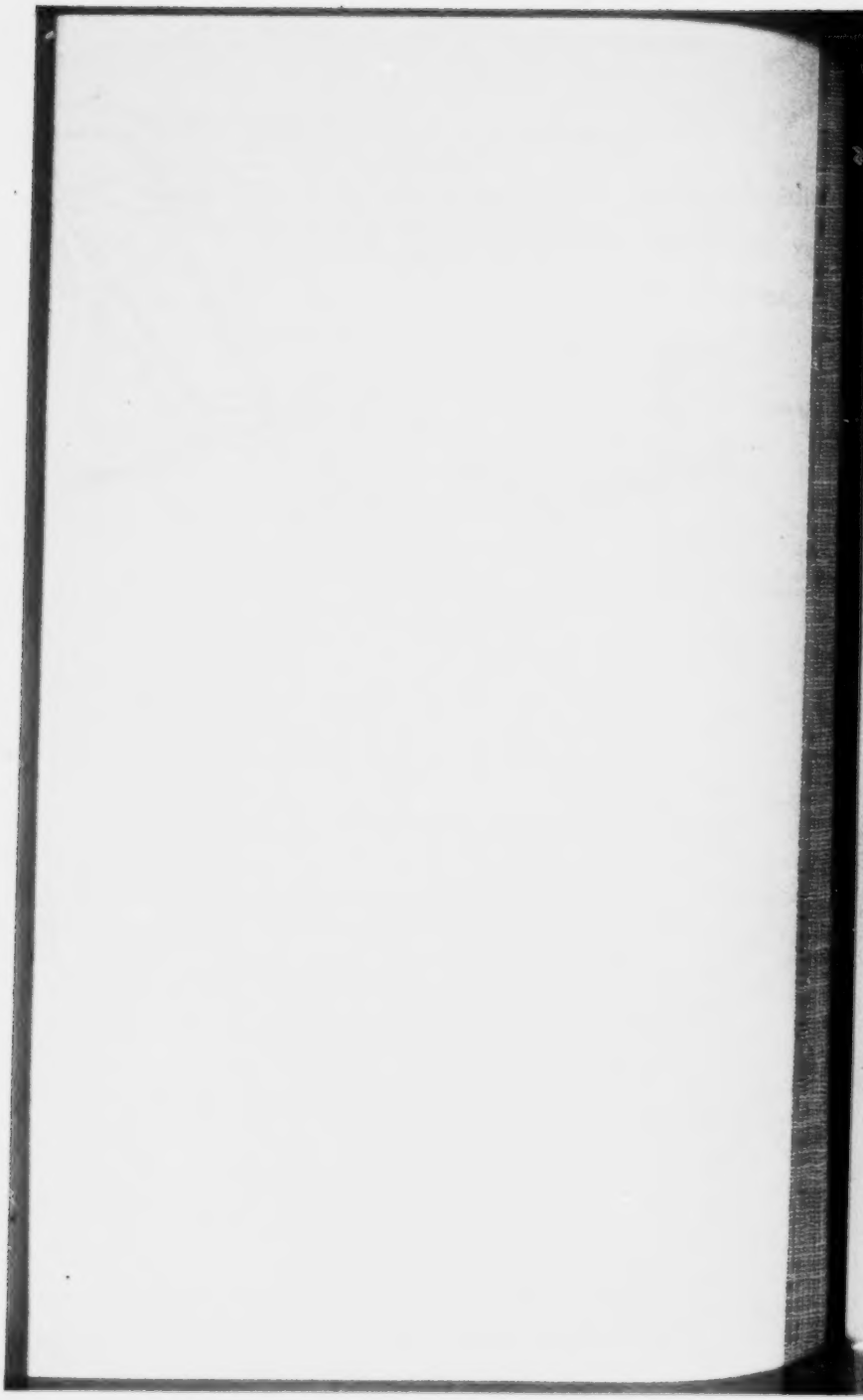


164

PENNSYLVANIA EXHIBIT 39 H.

Offered at p. 876 of Printed Record by Witness Wyer.

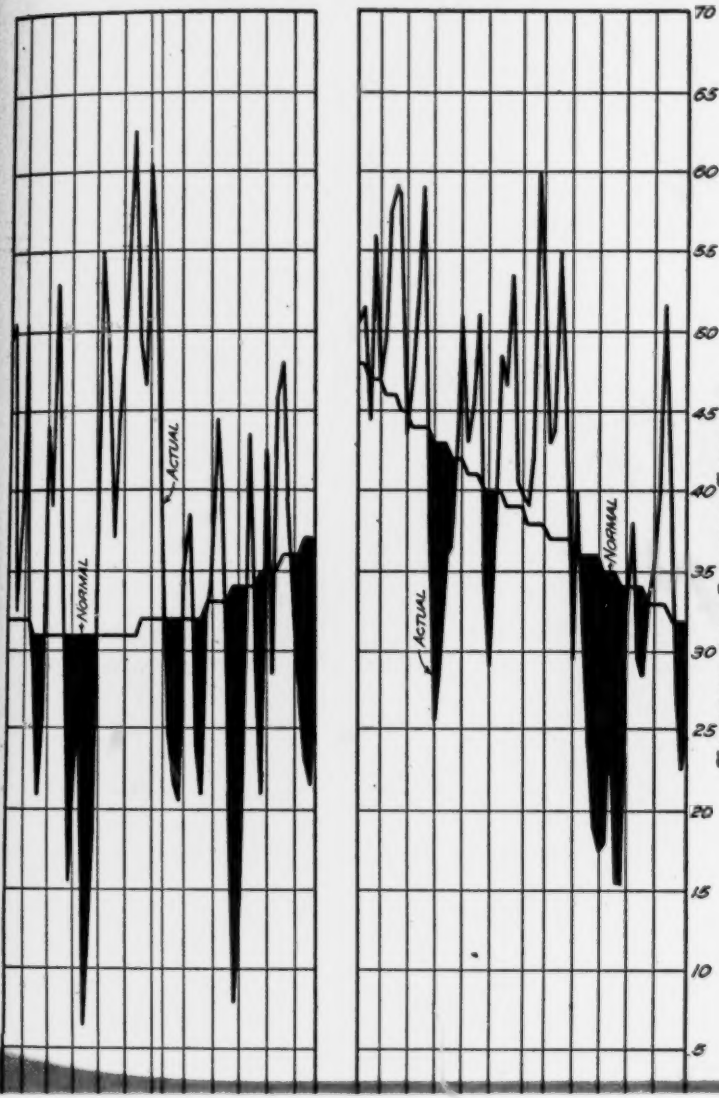
Eastern Oil Company Map.



DAILY, ACTUAL AND NORMAL ATMOSPHERIC TEMPERATURES AT PARKERSBURG, WEST VIRGINIA

Based on the United States Weather Bureau records for 1916.

The shaded area below the normal temperature line represents the temperature deficiency and the low points are the ones that create such abnormal demands for domestic natural gas service that necessitate the curtailing of industrial gas during such periods.



PENNSYLVANIA EXHIBIT 40 A.

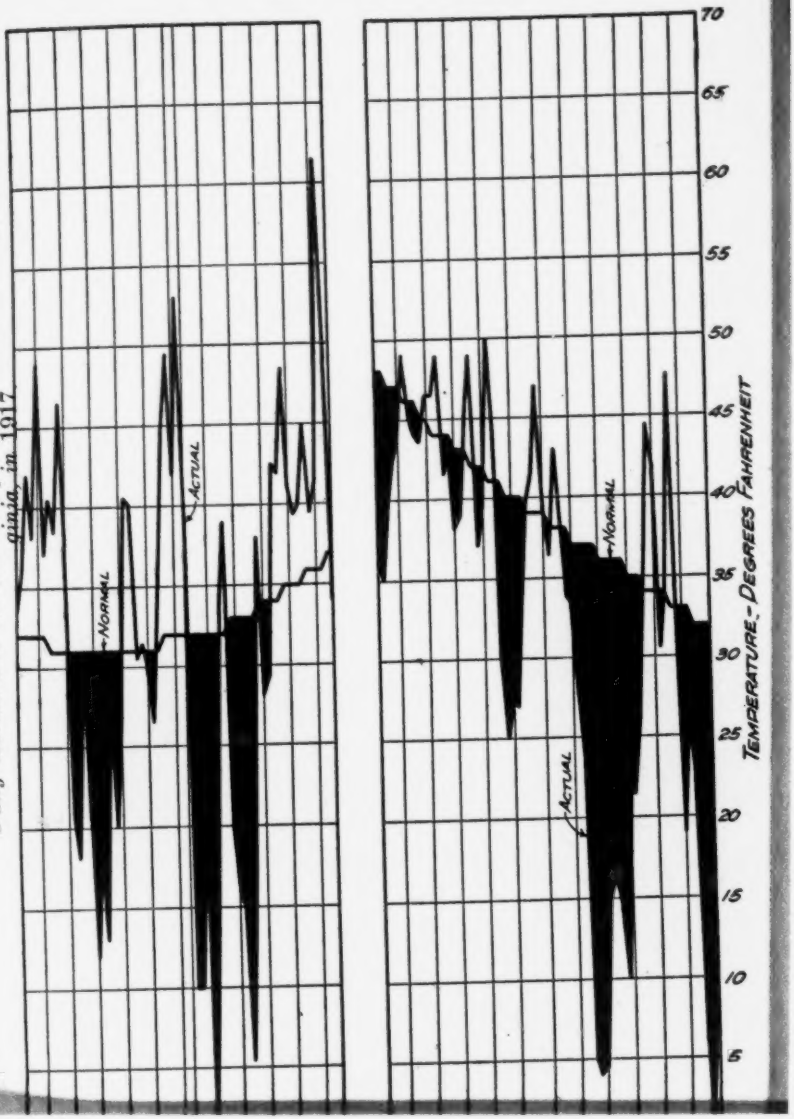
165 Offered at p. 893 of Printed Record by Witness Wyer.

Daily Actual and Normal Temperature at Parkersburg, West Virginia, in 1916.

DAILY, ACTUAL AND NORMAL ATMOSPHERIC TEMPERATURES AT PARKERSBURG, WEST VIRGINIA

Based on the United States Weather Bureau records for 1917.

The shaded area below the normal temperature line represents the temperature deficiency and the low points are the ones that create such abnormal demands for domestic natural gas service that necessitate the curtailing of industrial gas during such periods.

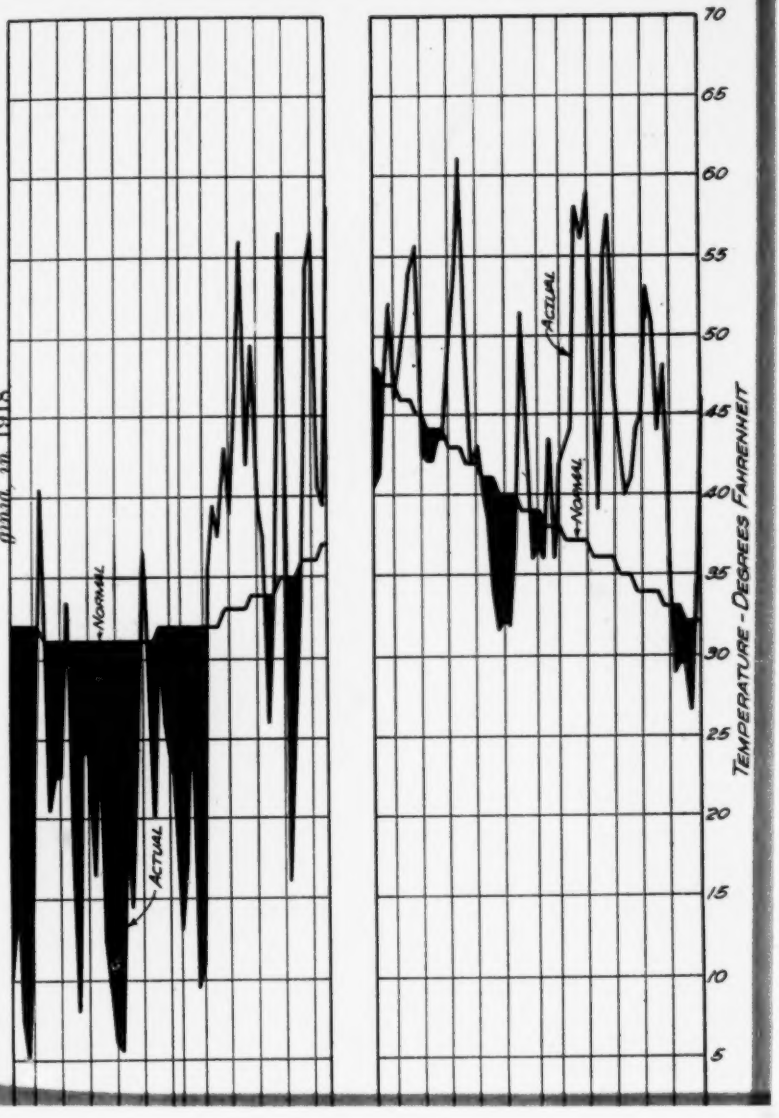


Offered at p. 893 of Printed Record by Witness Wyer.
Daily Actual and Normal Temperature at Parkersburg, West Virginia, in 1917

DAILY, ACTUAL AND NORMAL ATMOSPHERIC TEMPERATURES AT PARKERSBURG, WEST VIRGINIA

Based on the United States Weather Bureau records for 1918.

The shaded area below the normal temperature line represents the temperature deficiency and the low points are the ones that create such abnormal demands for domestic natural gas service that necessitate the curtailing of industrial gas during such periods.



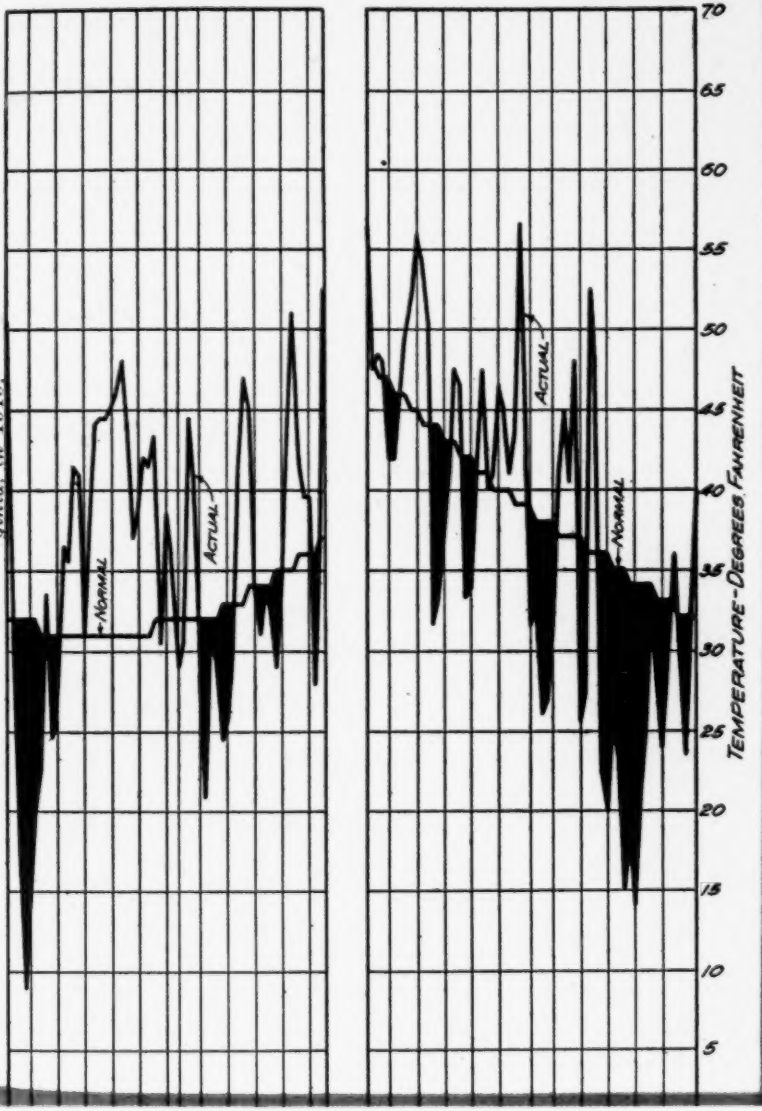
Offered at p. 893 of Printed Record by Witness Wyer.

Daily Actual and Normal Temperature at Parkersburg, West Virginia, in 1918.

DAILY, ACTUAL AND NORMAL ATMOSPHERIC TEMPERATURES AT PARKERSBURG, WEST VIRGINIA

Based on the United States Weather Bureau records for 1919.

The shaded area below the normal temperature line represents the temperature deficiency and the low points are the ones that create such abnormal demands for domestic natural gas service that necessitate the curtailing of industrial gas during such periods.



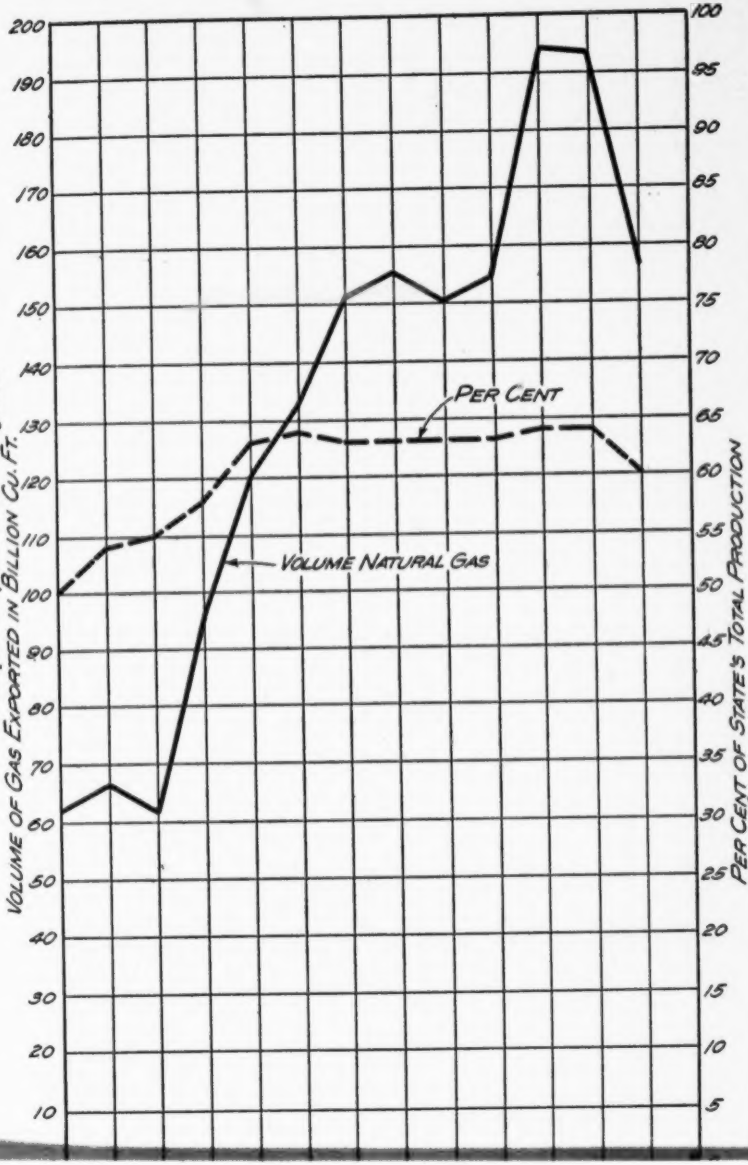
168 PENNSYLVANIA EXHIBIT 40 D.
Offered at p. 893 of Printed Record by Witness Wyer.
Daily Actual and Normal Temperature at Parkersburg, West Virginia, in 1919.

Offered at p. 895 of Printed Record by Witness Wyer.

Volume of Natural Gas and Per Cent of State's Total Production Exported from West Virginia.

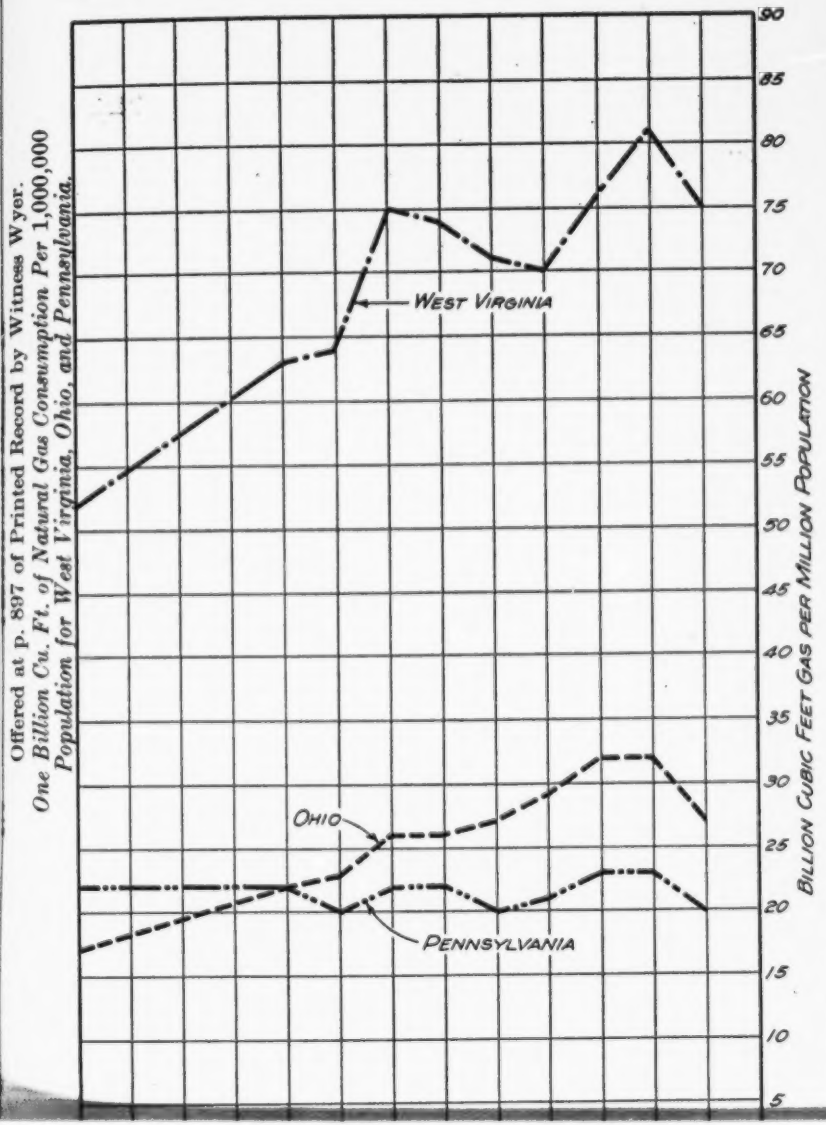
VOLUME NATURAL GAS
AND
PER CENT OF STATE'S TOTAL PRODUCTION
EXPORTED FROM WEST VIRGINIA

Based on data compiled by the United States Geological Survey.



BILLION CUBIC FEET NATURAL GAS CONSUMED PER MILLION POPULATION IN WEST VIRGINIA, OHIO AND PENNSYLVANIA

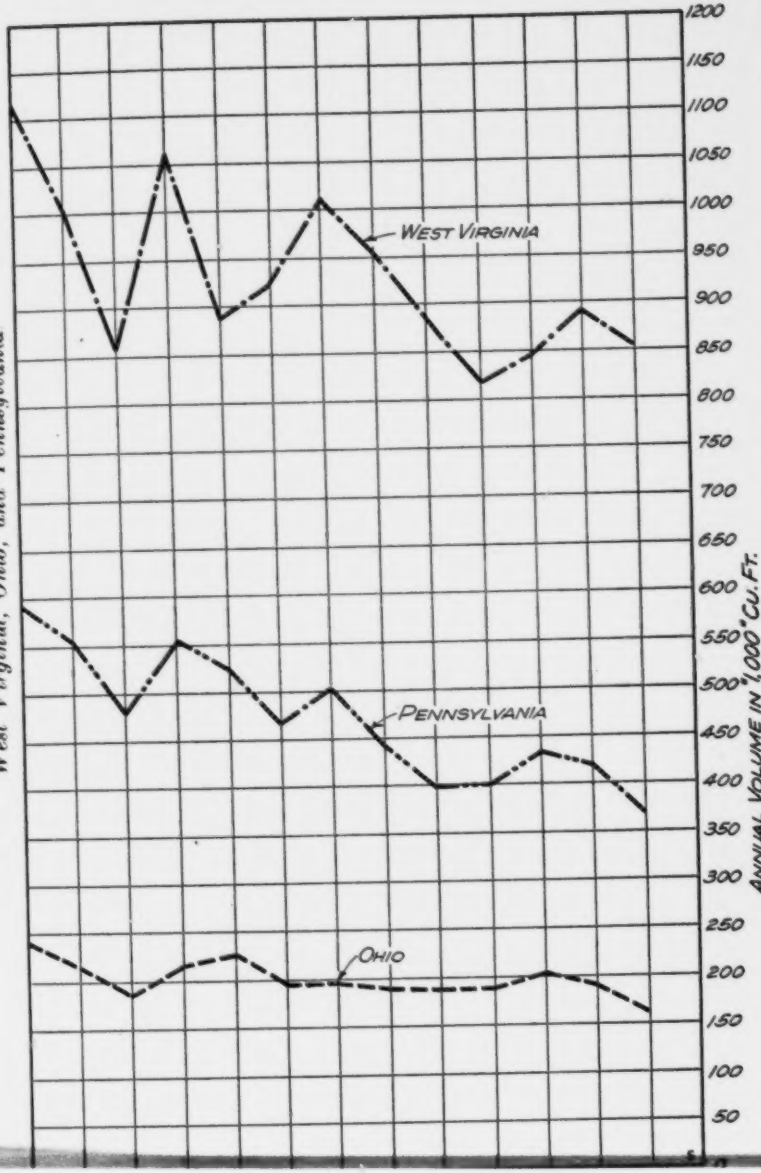
The population data were furnished by the Bureau of the Census and the natural gas data by the United States Geological Survey.



Offered at p. 897 of Printed Record by Witness Wyer.
One Billion Cu. Ft. of Natural Gas Consumption Per 1,000,000 Population for West Virginia, Ohio, and Pennsylvania.

TOTAL NATURAL GAS CONSUMED ANNUALLY PER DOMESTIC CONSUMER IN WEST VIRGINIA, OHIO AND PENNSYLVANIA

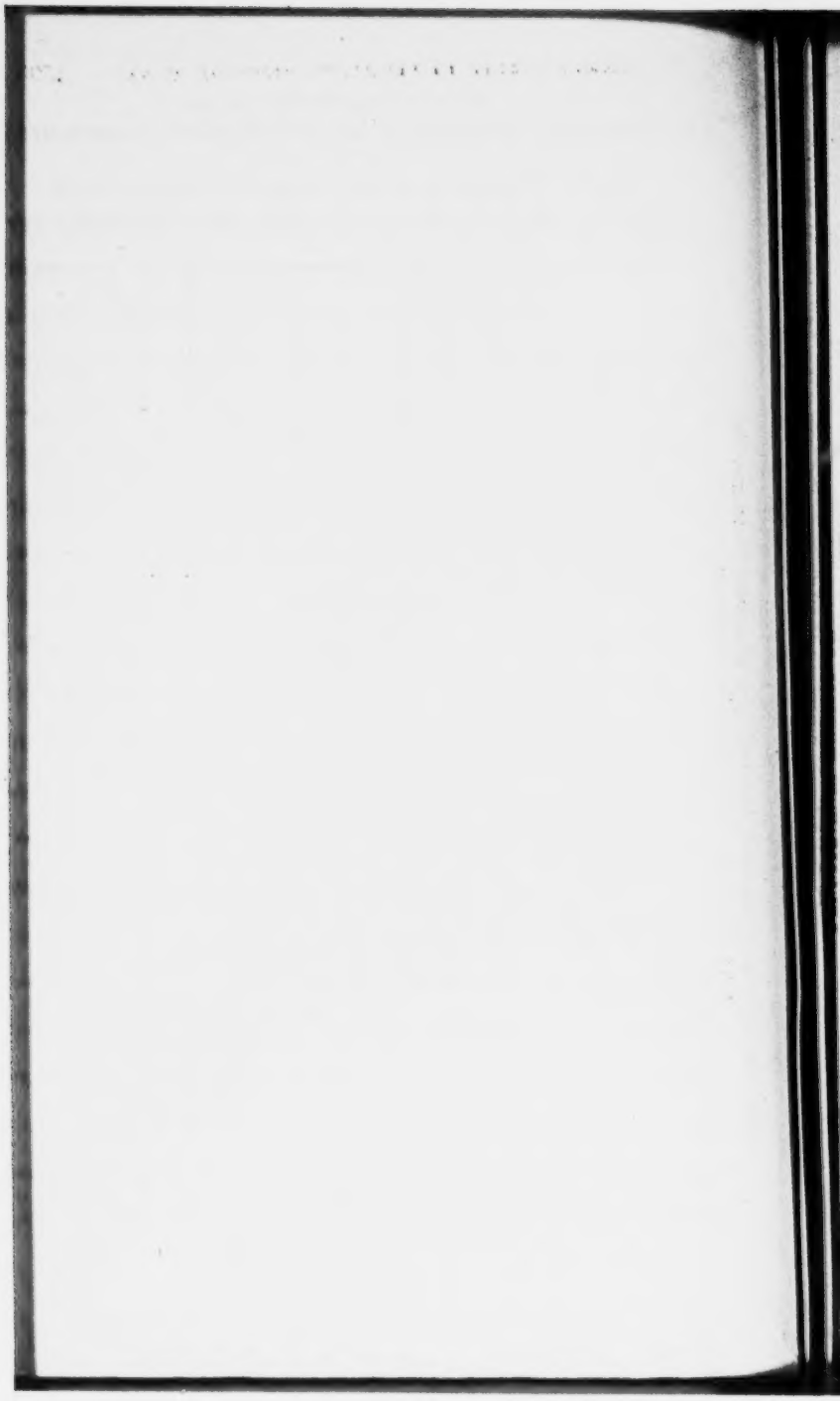
Based on data compiled by the United States Geological Survey.



PENNSYLVANIA EXHIBIT 43.

171 Offered at p. 897 of Printed Record by Witness Wyer.

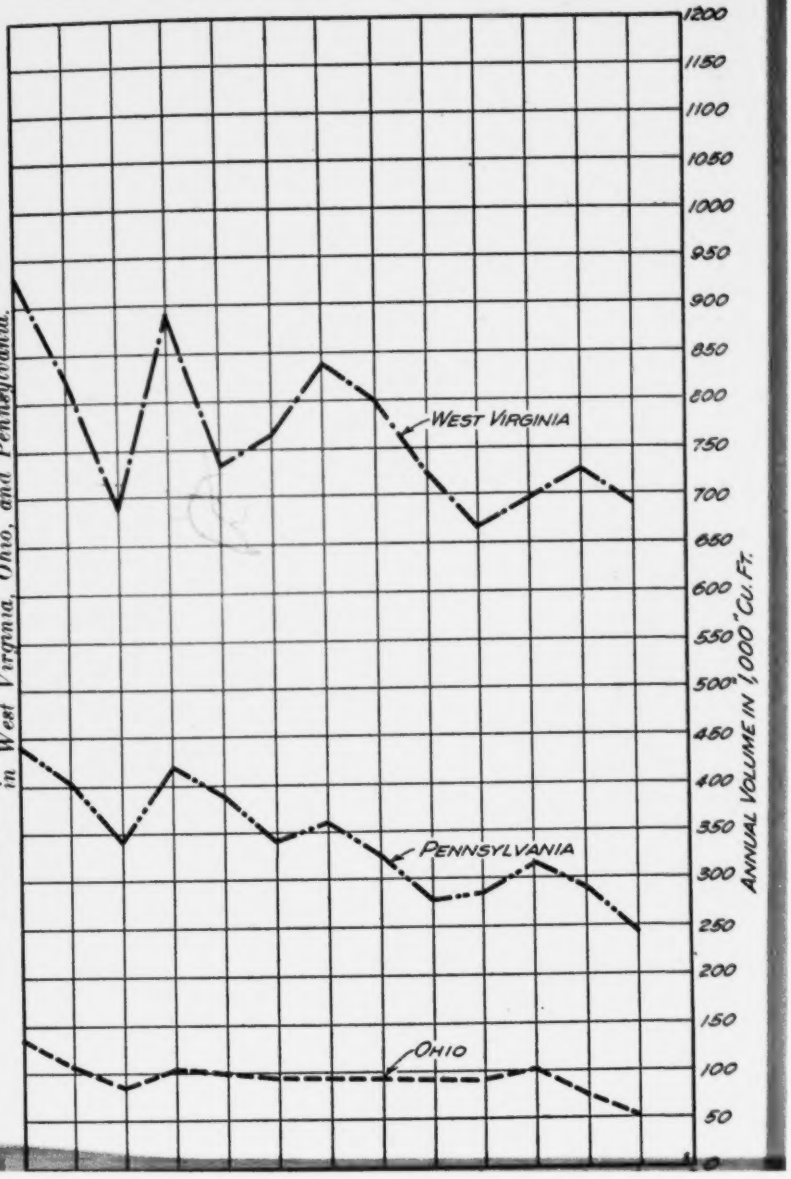
Total Natural Gas Consumed Annually per Domestic Consumer in West Virginia, Ohio, and Pennsylvania



Offered at p. 897 of Printed Record by Witness Wyer.
Industrial Natural Gas Consumed Annually per Domestic Consumer in West Virginia, Ohio, and Pennsylvania.

INDUSTRIAL NATURAL GAS CONSUMED ANNUALLY PER DOMESTIC CONSUMER IN WEST VIRGINIA, OHIO AND PENNSYLVANIA

Based on data compiled by the United States Geological Survey



Offered at p. 898 of Printed Record by Witness Wyer.

Domestic Gas Consumed Annually per Domestic Consumer in West Virginia, Ohio, and Pennsylvania.

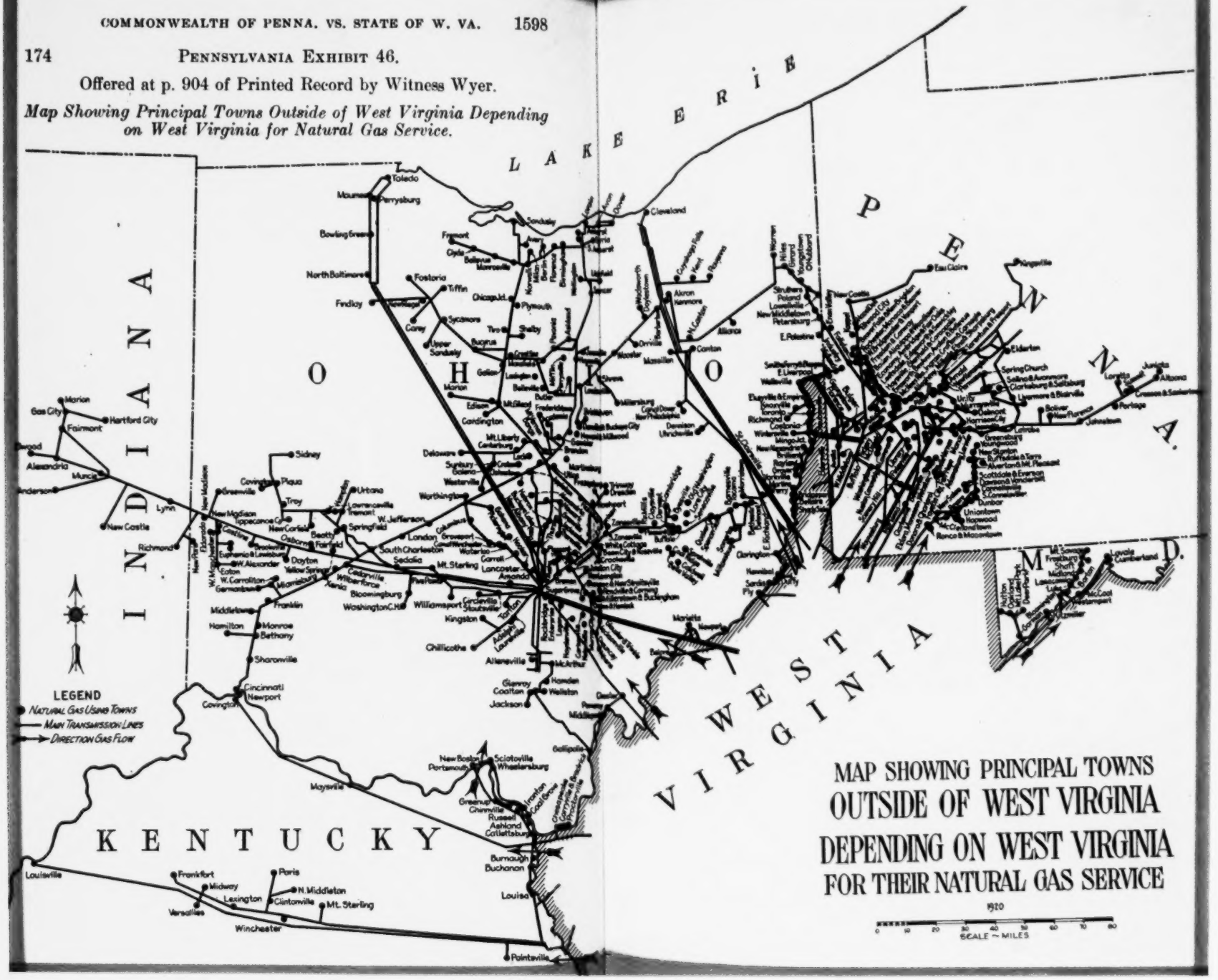
DOMESTIC NATURAL GAS CONSUMED ANNUALLY PER DOMESTIC CONSUMER IN WEST VIRGINIA, OHIO AND PENNSYLVANIA

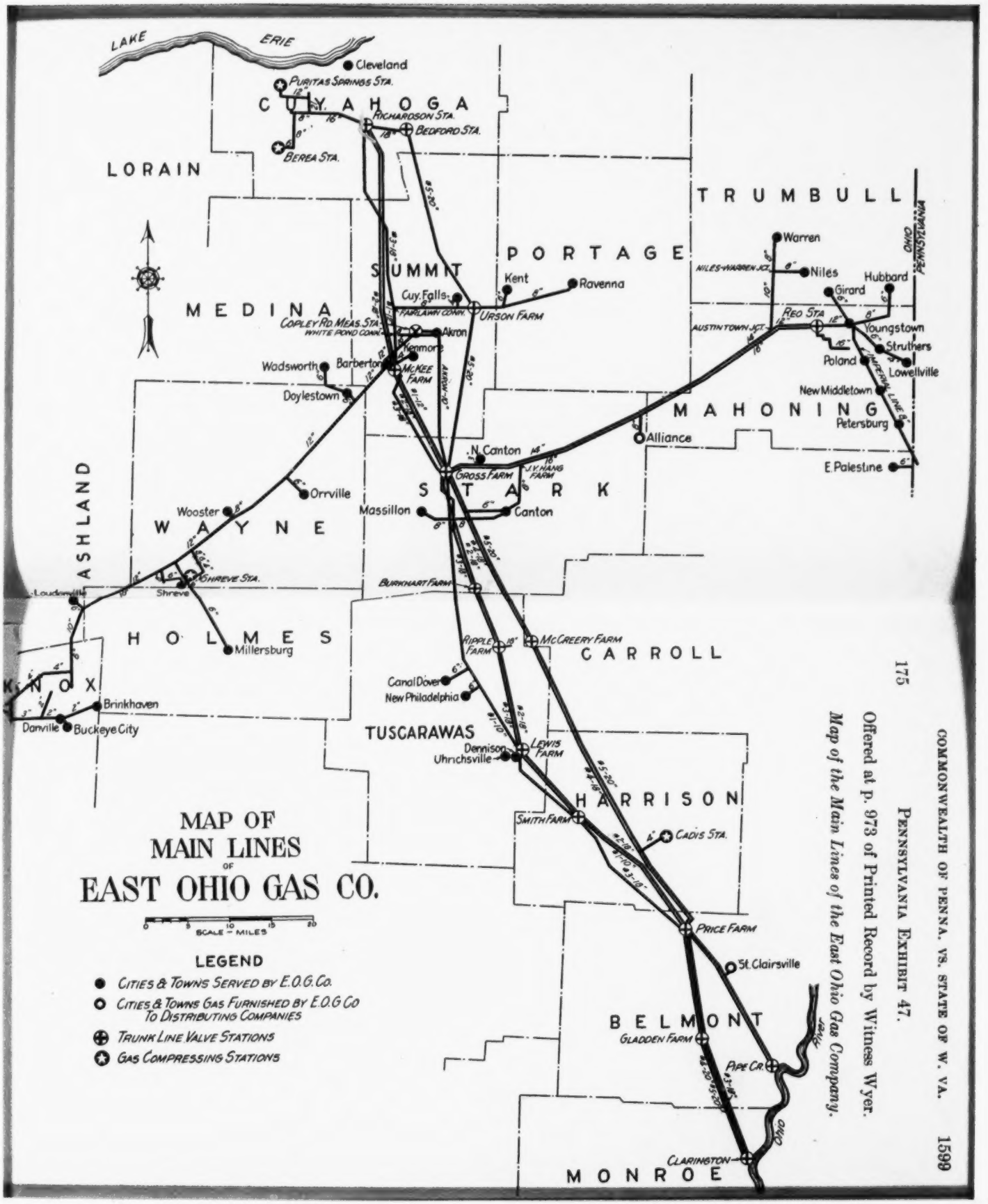
Based on data compiled by the United States Geological Survey.

174 PENNSYLVANIA EXHIBIT 46.

Offered at p. 904 of Printed Record by Witness Wyer.

Map Showing Principal Towns Outside of West Virginia Depending on West Virginia for Natural Gas Service.





COMMONWEALTH OF PENNA. VS. STATE OF W. VA. 1599

PENNSYLVANIA EXHIBIT 47.

Offered at p. 973 of Printed Record by Witness Wyer.

Map of the Main Lines of the East Ohio Gas Company.

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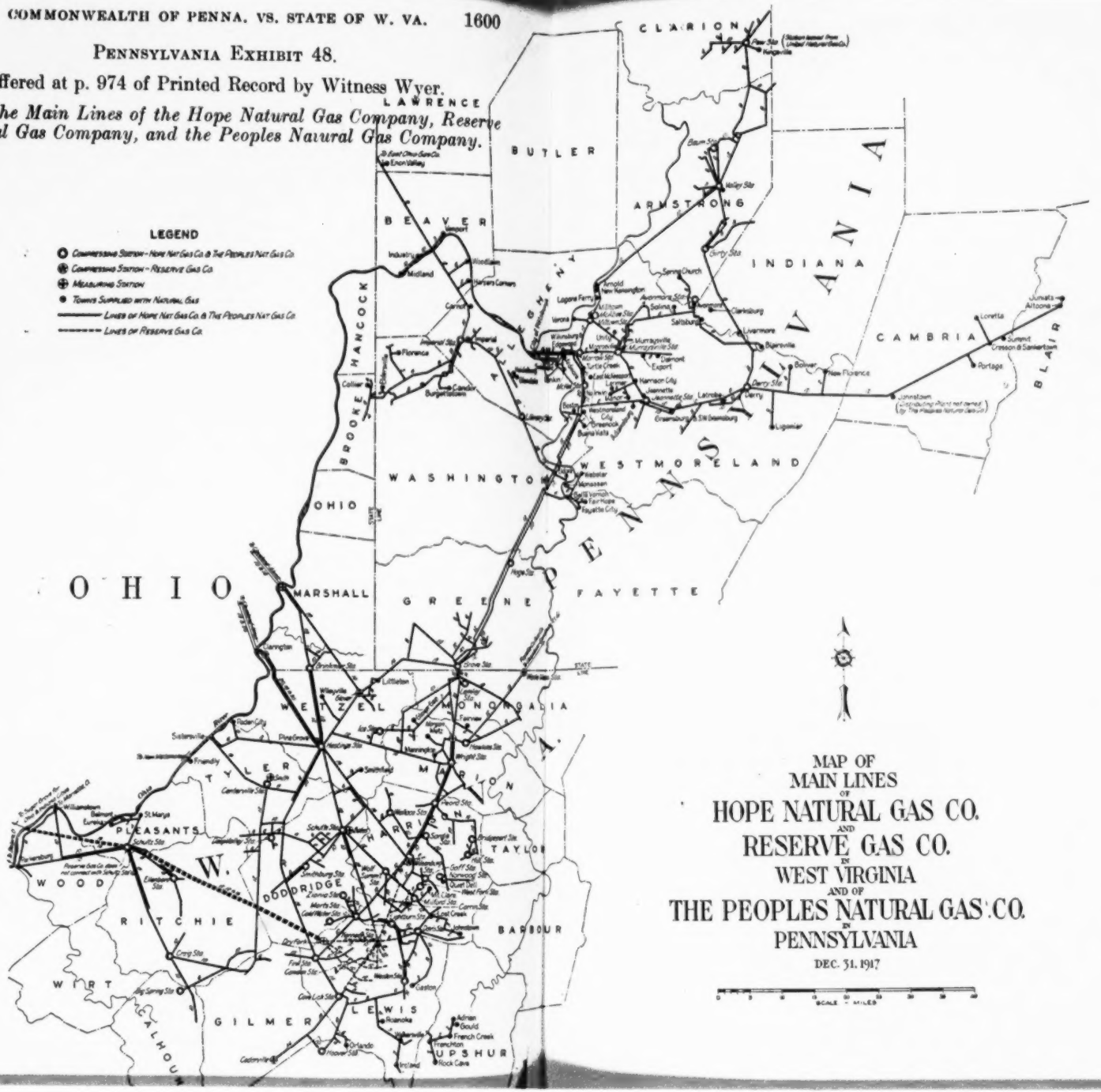
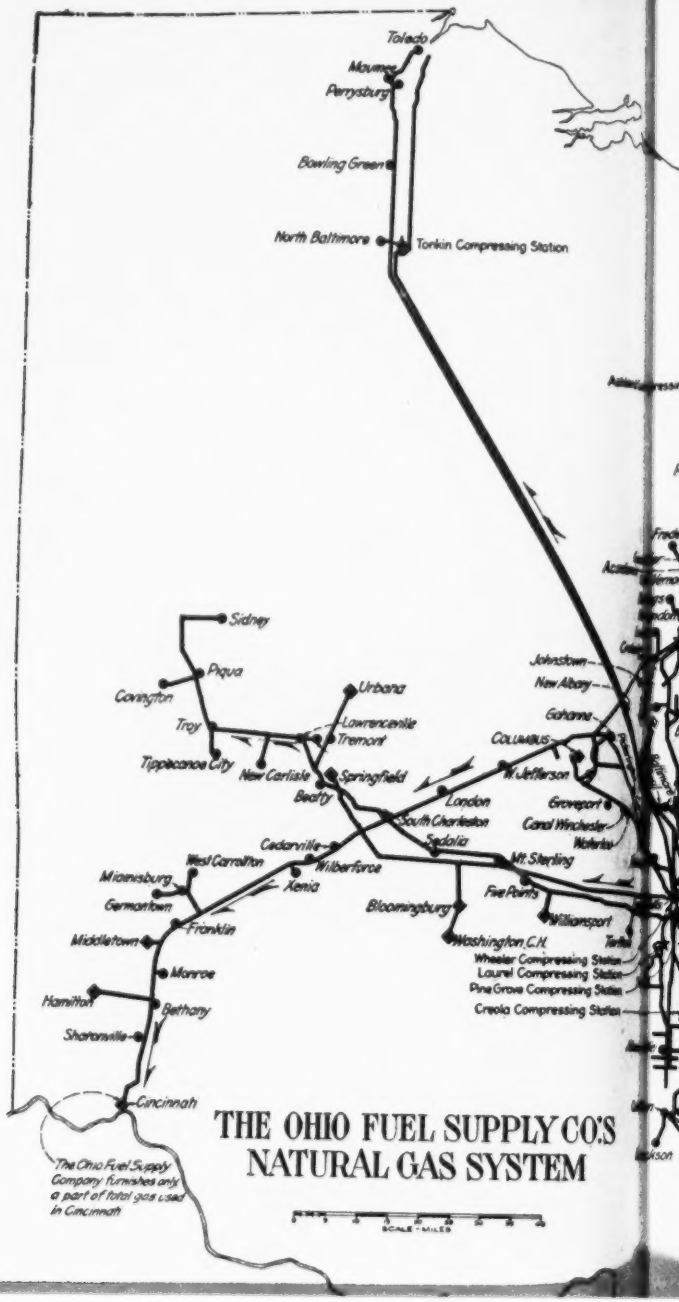
176 PENNSYLVANIA EXHIBIT 48.

Offered at p. 974 of Printed Record by Witness Wyer.

Map of the Main Lines of the Hope Natural Gas Company, Reserve Natural Gas Company, and the Peoples Natural Gas Company.




Toledo
Maumee
Perrysburg
Bowling Green
North Baltimore
Tonkin Compressing Station
Sidney
Piqua
Covington
Urbana
Troy
Lawrenceville
Tremont
Tippecanoe City
New Carlisle
Springfield
Beatty
Cedarville
Wilberforce
West Carrollton
Miamisburg
Xenia
Germantown
Franklin
Middletown
Monroe
Hamilton
Bethany
Shandonville
Cincinnati
Johnstown
New Albany
Gahanna
COLUMBUS
W. Jefferson
London
South Charleston
Sedalia
Groveport
Canal Winchester
Waterloo
Mt. Sterling
Five Points
Bloomingsburg
Williamsport
Washington C.H.
Wheeler Compressing Station
Laurel Compressing Station
Pine Grove Compressing Station
Creola Compressing Station
THE OHIO FUEL SUPPLY CO.'S
NATURAL GAS SYSTEM
The Ohio Fuel Supply Company furnishes only a part of total gas used in Cincinnati
SCALE - MILES

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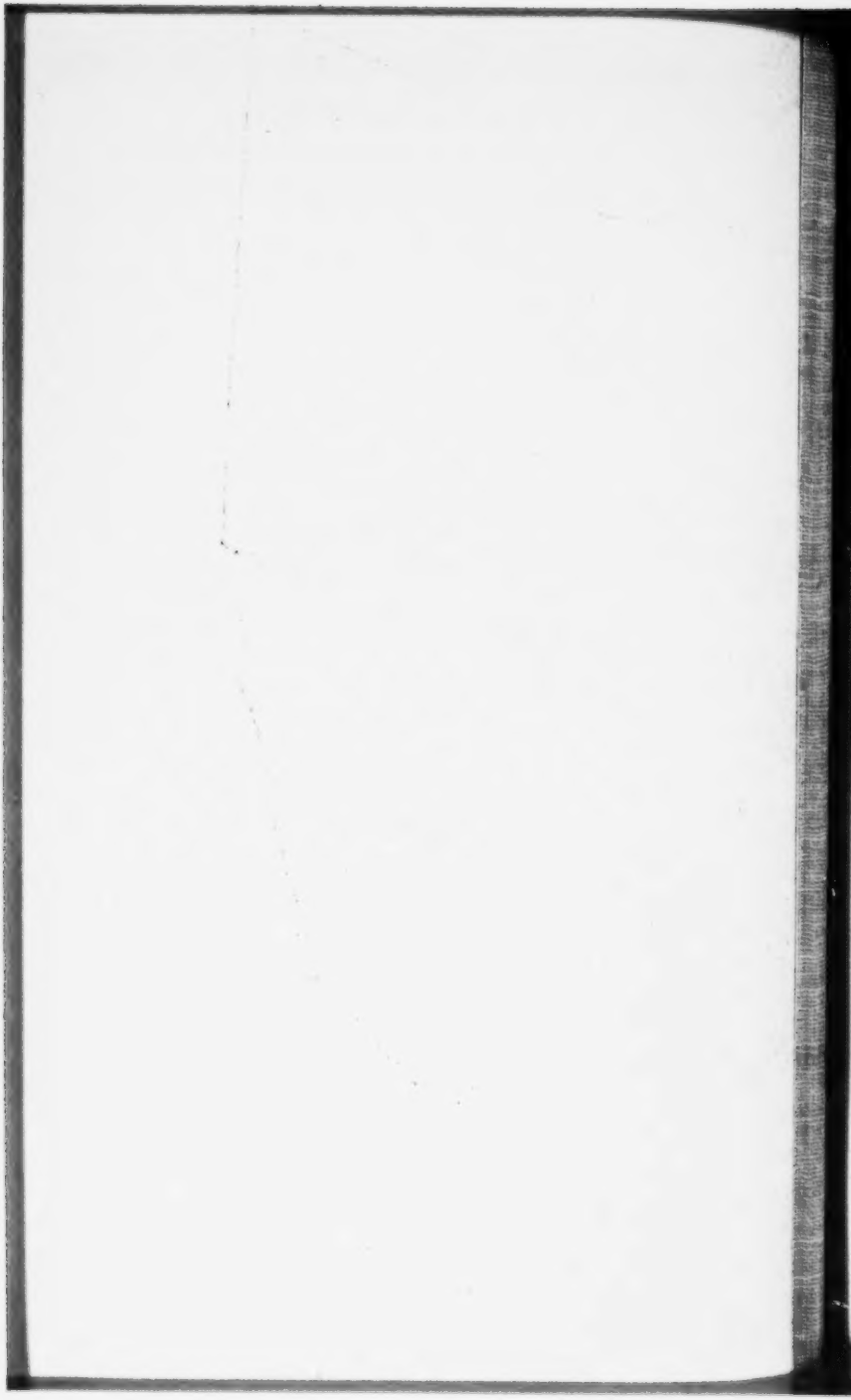
PENNSYLVANIA EXHIBIT 49.

Offered at p. 974 of Printed Record by Witness Wyer.

Map of the Ohio Fuel Supply Company's System.



178 PA. EXHIBIT No. 50. J. R. S.

3/22/1921.

Natural Gas Statistics—State of West Virginia.

The total production of natural gas, within the State of West Virginia, for the year ended December 31, 1919, was approximately 220 billion cubic feet. Approximately 80 billion cubic feet of the State's production (or the equivalent thereof) and 4 billion cubic feet of imported gas was consumed within West Virginia and approximately 140 billion cubic feet piped to other States.

The production of natural gas within West Virginia for the years 1908 to 1919, both years inclusive, was as follows:

Year.	Cubic feet.
1908	112,181,278,000
1909	166,435,092,000
1910	190,705,869,000
1911	206,890,576,000
1912	239,006,682,000
1913	245,453,985,000
1914	236,489,175,000
1915	244,004,159,000
1916	299,318,907,000
1917	289,898,967,000
1918	280,289,044,000
1919	219,886,837,000

The statement following shows the quantity of natural gas exported from the State.

Year.	Exported from State (cubic feet).	Percentage of State's total production.
1908	61,644,618,000	55%
1909	96,074,387,000	58%
1910	120,508,811,000	63%
1911	132,867,059,000	64%
1912	151,144,250,000	63%
1913	155,501,876,000	63%
1914	150,161,936,000	63%
1915	154,630,164,000	63%
1916	200,004,740,000	67%
1917	196,679,263,000	68%
1918	174,664,650,000	62%
1919	139,939,062,000	64%

The consumption of gas within the State was as follows:

Year.	Consumption within State (cubic feet).	Percentage of State's total production.
1908	50,536,660,000	45%
1909	70,360,705,000	42%
179		
1910	70,197,058,000	37%
1911	74,023,517,000	36%
1912	87,862,432,000	37%
1913	89,952,109,000	37%
1914	86,327,239,000	37%
1915	89,373,995,000	37%
1916	99,314,167,000	33%
1917	93,220,204,000	32%
1918	105,624,394,000	38%
1919	83,769,937,000	36%

These figures include gas imported from other States. The importations for 1919 were 382,162,100 cubic feet.

Following are statements showing the consumption of natural gas within West Virginia by different classes of consumers.

Domestic Consumers.

Year.	Number consumers.	Gas consumed (cubic feet).	Percentage of State's total production.
1909	57,208	9,907,023,000	5.6%
1910	71,900	11,173,508,000	5.9%
1911	70,880	11,311,715,000	5.5%
1912	74,985	13,288,159,000	5.6%
1913	82,139	12,961,799,000	5.3%
1914	88,344	14,265,209,000	6.0%
1915	94,098	15,220,207,000	6.3%
1916	109,216	15,237,221,000	5.1%
1917	122,329	16,404,234,000	5.5%
1918	125,341	19,618,873,000	6.9%
1919	130,780	18,753,986,000	8.5%

FOLDOUT(S) IS/ARE TOO LARGE TO BE FILMED

Industrial Consumers.

Year.	Gas consumed (cubic feet).	Percentage of State's total production.
1909	60,453,682,000	36.4%
1910	59,023,550,000	31.1%
1911	62,711,802,000	30.5%
1912	74,574,273,000	31.4%
1913	76,990,310,000	31.7%
1914	72,062,030,000	31.0%
1915	74,153,788,000	30.7%
1916	83,767,519,000	27.9%
1917	76,816,465,000	26.5%
1918	86,005,521,000	31.1%
1919	65,015,951,000	27.5%

Large quantities of natural gas are used within the State in the manufacture of carbon black. The average yearly consumption for the last ten years for this purpose was approximately 23 billion cubic feet per year. During the year 1919, approximately 21 billion cubic feet was used for this purpose. The figures for "Industrial Consumption" include this gas.

Prepared by H. E. Nease, Statistician, Public Service Commission of W. Va.

(Here follow Pennsylvania Exhibits 51 and 52, marked pages 179*a*-181, inclusive.

181*a*

PENNSYLVANIA EXHIBIT 53.

Offered at p. 1383 in Printed Record by Witness Robinson.

Ebert's Statement on West Virginia Natural Gas Production, Importation, Sales, and Exportation for Year 1920.

PA. EXHIBIT No. 53. 3-21-1921. J. R. S.

182

Inspection Department, Gas Utilities.

Summary of the Natural Gas Production, Importation, Sales, and Exportation for the Fiscal Year Ending June 30, 1920.

I.	Sold in cities and towns in W. Va.	51,525,765 Mcf.		
J.	" " field and main lines "	35,883,029 "		
K.	Total sales in W. Va.	87,408,794 "	87,408,794 Mcf.	
L.	Sold to W. Va. utilities		48,806,800 "	
M.	Exported from W. Va.		142,519,562 "	
N.	Line loss, etc.		66,357 "	
O.	Credit total		278,801,513 Mcf.	
C.	Purchased from W. Va. producers	34,932,777 Mcf.	from 1,074–2/12 wells.*	
E.	" " " utilities	49,012,245 "		
F.	Imported to W. Va.	5,435,663 "		

G.	Error in reporting	326	"	
	Total purchases and imports	89,381,011	"	89,381,011 Mcf.
B.	Produced by utilities from 7,709–5/12 wells*			189,420,502 "
H.	Debit total			278,801,513 "

In item F, 755,666,000 cubic feet of the 5,435,663,000, was "forced importation" through a main trunk line, from the McKeesport, Pa., gas field, while the latter was in its prime. While the utility exports gas to Pennsylvania regularly and imports none from Pennsylvania, it was compelled to take the quantity named above during one month.

CHAS. B. EBERT,
Acting Chief Inspector.

*Monthly average of wells.

182a PENNSYLVANIA EXHIBIT 54.

Offered at p. 1391 of Printed Record by Witness Robinson.

Statement Showing Approximate Acreage Held by Certain Companies and Individuals in West Virginia.

183 . PA. EX. No. 54. J. R. S. 3/21/1921.

Statement Showing Approximate Acreage Held by Certain Companies and Individuals Operating for Oil and Gas in West Virginia at Approximately Present Time.

(1)

	Developed.	Undeveloped.	Total.
Anchor Oil Co.	380	64	444
Anderson & Co.	77	.....	77
Aizpuru Oil & Gas Co.	308	.....	308
Armstrong, F. W.	110	.....	110
Armstrong, F. W. & Sons	246	.....	246
Allegheny Oil & Gas Co.	198	306	504
Arkansas Natural Gas Co. (or J. R. Munce)	.....	3,094	3,094
Anderson Oil & Gas Co.	50	.....	50
Ahouse, George	29	160	189
Ahner, W. H.	20	990	1,010
Bartlett, Fred	350	.....	350
Blair & Butler	5	2,767	2,772
Betts, Chas. H.	600	400	1,000
Brast, E. A.	125	815	940
Beren & Wright	100	300	400
Brown, C. L.	.....	150	150
Bowser, Park	1,383	2,197	3,580
Beacon Oil & Gas Co.	2,000	.....	2,000
Bishop & Co.	142	.....	142
Barnhart & Elder	.....	325	325
Barnhart & Moore	25	.....	25
Beeghley, Lloyd et al	.....	33	33
Benson Oil Co.	.....	80	80
Burnsville Oil & Gas Co.	100	.....	100
Buckhannon Chemical Co.	.....	4,000	4,000
Boggess, Lee	40	.....	40
Boone Oil & Gas Co.	10	.....	10
Beer, B. F. & Co.	65	.....	65
Bradley & Moon Oil & Gas Co.	241	.....	241
Bennett Farm Oil Co.	130	.....	130
Bunnell Oil & Gas Co., et al.	45	.....	45
Bridgeport Natural Gas & Oil Co.	518	65	583

	Developed.	Undeveloped.	Total.
Blue Flame Oil & Gas Co.	512	200	712
Berkley Oil Co.	40	300	340
Bumpus, John I.	90	.....	90
Bray, Edward M.	90	.....	90
Blacksville Oil & Gas Co.	192	.....	192
Beren & Co.	1,150	.....	1,150
Bennett, Ahner & Thompson	237	237	474
Charlton, Jim, Oil Co.	40	.....	40
Cincinnati Oil & Gas Co. et al	368	28	396
Cabin Creek Gas Co.	8,005	.....	8,005
Cabin Creek Oil Development Co.	200	5,544	5,744
Charleston-Dunbar Natural Gas Co.	1,650	25,899	27,549
Continental Oil & Gas Co.	1,425	1,140	2,565
Colonial Oil Co.	1,298	.....	1,298
Champion Oil & Gas Co.	1,505	.....	1,505
Craig Oil Co.	70	.....	70
Chalmers Oil & Gas Co.	750	.....	750
Center Fuel Co.	100	1,050	1,150
Cornwallis Oil & Gas Co.	625	100	725
Coltrane, J. N., et al	64	.....	64
Clay District Oil & Gas Co.	.....	44	44
Cummings Oil & Gas Co.	50	.....	50
Carnahan, J. E. & Co.	275	.....	275
Cowl, R. M. & Kate S.	400	.....	400
Chapman, Wm. J.	327	30	357
Chambers Oil Co.	100	.....	100
Carmichael, Floyd et al	.....	114	114
	26,860	50,432	77,292

(2)

184	Coogle & Allen	25	.....	25
	County Farm Oil Co.	200	.....	200
	Crystal Petroleum Co.	117	.....	117
	Corpening, Geo. B.	122	.....	122
	Craig-Gerber Oil & Gas Co.	64	800	864
	Crowley, Thomas & Co.	243	.....	243
	Carter & Engle	642	.....	642
	Capital City Oil Co.	370	126	496
	Crawford Oil & Gas Co.	400	.....	400
	Commonwealth Petroleum Co.	959	17,641	18,600
	Cotherman, F. A.	41	.....	41
	Clear Water Oil & Gas Co.	180	.....	180
	Crago, James	62	.....	62
	Carter, D. J., et al	850	3,950	4,800
	Crowley, M. F. & Co.	351	662	1,013
	Cochran & Funk	888	.....	888
	Conings Oil & Gas Co.	1,000	.....	1,000

	Developed.	Undeveloped.	Total.
Dental Oil Co.	738	.....	738
Del Rio Petroleum Co.	1,765	150	1,915
Dotson, M. C. & Co.	300	75	375
Delvatex Petroleum Corporation	288	.....	288
Despard, C. S.	.....	100	100
Delta Oil & Gas Co.	65	.....	65
Dotson, C. D., et al	462	.....	462
Dinsmoor Companies	10,000	400	10,400
Deaton, Harry	171	122	293
Dellenboch Oil & Gas Co.	235	.....	235
Dudeon Oil Co.	.....	600	600
Daugherty & Fuccy	110	.....	110
Dakon Coal & Oil Co.	135	450	585
Delmar Oil Co.	2,318	260	2,578
Eastern Petroleum Co.	5,673	5,776	11,449
Empire Petroleum Co.	3,910	1,186	5,096
Eastern Producing & Refining Co.	1,229	570	1,799
Engle & McElwain	.....	1,000	1,000
Eagle District Gas Co.	160	.....	160
Economy Oil Co.	167	.....	167
Easton & Hickman Oil Co.	260	.....	260
Eddystone Oil Corporation	4,788	7,665	12,453
Eureka Oil Co.	10	.....	10
Freehold Oil & Gas Co.	818	41	859
Fisher Oil Co.	3,709	49,029	52,727
Freshwater, F. L.	257	.....	257
Funk & Null	60	170	230
Fink, H. B., Estate	250	.....	250
Figley, F. S. & Co.	31	.....	31
Gurmer Oil Co.	94	92	186
Greenleaf & Starcher	13	.....	13
Goshorn Oil Co.	200	.....	200
Gas Products Co.	470	.....	470
	45,200	90,865	136,065

(3)

185 Grant Oil Co.	217	.....	217
Grasselli Chemical Co.	1,958	50	2,008
Gay Gas Co.	277	1,100	1,377
Goettman, C. E.	573	2,471	3,044
Gambrill, Mary S.	563	.....	563
Gribble, Jno. M. & W. D.	715	110	825
Gibs, D. M.	.....	500	500
Grass Run Oil & Gas Co.	68	.....	68

	Developed.	Undeveloped.	Total.
Gem Oil & Gas Co.	32	.....	32
Greater Pittsburg Oil & Gas Co.	950	.....	950
Hamkins Oil & Gas Co.	159	.....	159
Huntington Development Co.	23,000	120,000	143,000
Hart Farm Oil Co.	90	.....	90
Hudson Oil Co.	943	100	1,043
Hiteshew & Walker	3,100	.....	3,100
Hays, S. A., et al	400	.....	400
Hosey Oil & Gas Co.	.....	205	205
Harmony Oil Co.	18	.....	18
Hornor Gas Supply Co.	72	.....	72
Hornor, V. L., et al	48	58	106
Hoke Bros.	100	.....	100
Hahn, Chas. F.	210	100	310
Hornor, Boyd E.	165	10	175
Hornor, J. Lee	477	.....	477
Hornor, L. S., Trustees &c.	300	4,000	4,000
Hudson, W. J.	250	.....	250
Hardly Able Gas Co.	230	770	1,000
Haskill & Hopkins	601	.....	601
Hornor, Boyd E., Special	.....	7,450	7,450
Harshbarger Oil & Gas Co.	2,500	500	3,000
Hatzel & Wilson	145	.....	145
Henderson, L. A.	.....	42	42
Imperial Oil & Gas Co.	3,200	6,800	10,000
Ingrim, J. T.	136	.....	136
Irvin, C. M. & Co.	160	230	390
Inter-State Gasoline & Oil Co.	280	410	690
Jennings Oil Co.	3,365	662	4,027
Jarvis Oil Co.	148	100	248
Jackson, J. O.	50	1,150	1,200
Jarvis, U. W.	50	.....	50
Johnson, J. W. & Sons	277	120	397
Johns-Van Vorhis	1,000	.....	1,000
Jonas Oil Co.	97	.....	97
Jennings, J. B.	100	.....	100
Koon, Hayes et al	450	.....	450
Knight Farm Oil Co.	130	.....	130
Koontz & Osborne	215	250	465
Kanawha Gas Co.	90	.....	90
Kanawha City Oil & Gas Co.	3,046	.....	3,046
Kings Creek Oil & Gas Co.	45	.....	45
Kanawha Valley Products Co.	2,200	.....	2,200
	53,200	147,188	200,388

(4)

	Developed.	Undeveloped.	Total.
186 Lewis Oil & Gas Co.	203	.....	203
Larimer Oil Co.	340	.....	340
Langley Oil Co.	44	73	117
Locke, J. T. & Co.	343	285	628
Lockhart, E. H.	516	680	1,196
Lumberport Gas Co.	37	43	80
Laurel Development Co.	650	350	1,000
Lemley Oil Co.	98	.....	98
Luton, H. L. & C.	200	64	264
Leonard Petroleum Co.	103	.....	103
La Belle Iron Works	592	.....	592
Little Sycamore Oil & Gas Co.	1,400	.....	1,400
Loughner, E. E.	200	.....	200
Linduff, John	119	.....	119
Lawrence Oil & Gas Co.	5	.....	5
Montgomery Gas Co.	1,142	.....	1,142
Miller, Geo. E.	.....	829	829
Marshall Oil Co.	518	1,923	2,441
Mabel Oil Co.	19	.....	19
Midwood Oil & Gas Co.	4,200	.....	4,200
Marne Oil & Gas Co.	711	.....	711
Means, W. A.	.....	215	215
Moon Oil & Gas Co.	455	.....	455
Marsh Bros. & Co.	75	.....	75
M. C. & S. Oil & Gas Co.	180	.....	180
Murphy, Michael estate	1,400	.....	1,400
Maxton Oil & Gas Co.	279	208	487
Martin, Mahlon	300	.....	300
Moore-Tex Oil Co.	267	20	287
Murray & Miller	100	.....	100
Mildren, John & Sons	138	.....	138
Mill Fork Oil & Gas Co.	800	1,200	2,000
Murray, James	350	1,654	2,004
Manufacturers Gas & Electric Co.	297	13	310
M. Edward Hersman Oil Co.	.....	1,767	1,767
Mills, J. L. & B. H.	87	.....	87
Mallory & Stewart	957	.....	957
Munce, J. R.	.....	3,124	3,124
Maxwell, W. Brent	1,300	.....	1,300
Murphy, Joseph L., Trustees et al.	1,782	.....	1,782
McBride, R. C., Inc.	41	.....	41
McMahon & Brafford	245	.....	245
McBride, W. H.	84	.....	84
McGinnis, J. W. & Co.	60	403	463
McDermott, J. H., Oil Co.	1,656	25	1,681

	Developed.	Undeveloped.	Total.
McCullough Oil Co.	50	300	350
McBride & Norris	200	.....	200
McKelvy Oil & Gas Co.	908	419	1,327
National Compressing Co.	38	.....	38
New York Petroleum Co.	1,013	.....	1,013
New Wilmington Oil & Gas Corp.	277	280	557
New Martinsville Oil Co.	214	.....	214
Netser, J. D.	25	300	315
Norwood Gas Co.	757	.....	757
	25,775	14,175	39,950

(5)

187 Ohio Fuel Oil Co.	2,785	83,658	86,443
Oil Creek Gas Co.	45	.....	45
Ohio Valley Trust Co.	526	.....	526
O'Connor, Martin	80	.....	80
Payn, Louis F. Oil Co.	2,783	.....	2,783
Power Oil Co.	601	200	801
Pope Bros. Oil Co.	1,142	2,016	3,158
Peaney, C. A., Oil Co.	137	.....	137
Patterson, W. C., Jr.,	2,170	.....	2,170
Pine Run Oil & Gas Co.	75	.....	75
Pugh & Cunningham	.....	200	200
Pentz, W. J.	.....	132	132
Patterson, Guy B. & Geo. B.	175	.....	175
Penn-Kentucky Oil Gasoline Refining Co.	1,749	.....	1,749
Peerless Carbon Black Co.	1,175	.....	1,175
Peach Oil Co.	25	50	75
Producers Development Co.	242	.....	242
Randolph & Lowther	145	394	539
Reed, E. R.	.....	1,785	1,785
Reno Oil Co.	3,675	.....	3,675
Roberts Brothers	436	800	1,236
Richwood Oil Co.	712	.....	712
Rouser Oil Co.	12	.....	12
Risk Oil & Gas Co.	200	1,000	1,200
Ramage, S. Y.	651	.....	651
Rock Bottom Oil & Gas Co.	78	.....	78
Randall Gas Co.	1,577	4,800	6,377
Rock Gas Products Co.	400	.....	400
Rockledge Oil Co.	2,100	718	2,818
Rose, J. B.	.....	121	121
Ripley Oil & Gas Co.	128	1,000	1,128

	Developed.	Undeveloped.	Total.
Riggs, S. V. & Co.	5	.....	5
Riggs-Hood Oil Co.	25	125	150
Ruth & Strong	350	50	400
Resolute Oil & Gas Co.	20	.....	20
Rogers & Fox	.....	2,000	2,000
Ring Oil Co.	5	.....	5
States Fork Oil Co.	438	500	938
Sayre, Ira G.	1,640	7,600	9,240
Sure Oil & Gas Co.	225	40	265
Stewart, Jas. D. & Chas. M.	454	.....	454
Silver Hill Oil Co.	800	300	1,100
Snider-Underwood & Co.	255	380	635
Samples Oil & Gas Co.	222	.....	222
Stathers, B. S., et al	.....	22	22
Smith Brothers	.....	54	54
Salem Fork Oil & Gas Co.	100	.....	100
Strother, Walton	42	.....	42
	28,405	107,945	136,350

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188 Schoffner Brothers	598	.....	598
Shinns Run Oil & Gas Co.	10	.....	10
Shinnston Gas Co.	5	.....	5
Shaffer-Smathers Oil Co.	16	.....	16
Sutton, W. L. & Son	108	.....	108
Shuman Oil & Gas Co.	.....	31	31
Simpson, B. M.	650	.....	650
Schultz Oil Co.	450	.....	450
Shady Glenn Oil Co.	350	.....	350
Stout & Maxwell	400	.....	400
Sutton Brothers, Inc.	739	.....	739
Snaith & Wilson	1,641	.....	1,641
Sandyville Oil & Gas Co.	184	2,000	2,184
Saba Oil Co.	150	.....	150
Sanders, D. E.	250	.....	250
Smith & McCullough	75	225	300
Sahley-Skoff Co.	7	.....	7
Silmon Oil Co.	75	.....	75
Shields Oil & Gas Co.	2,000	.....	2,000
Sleppy Oil Co.	300	.....	300
Shalto, B. D., et al	.....	1,000	1,000
Sovereign Gas Co.	2,250	2,150	4,400
Sago Oil & Gas Co.	.....	300	300
The Kanawha Oil Co.	6,337	.....	6,337
The Pure Oil Co.	16,393	139,594	155,987
The Buckeye Supply Co.	70	.....	70

	Developed.	Undeveloped.	Total.
Tenant Oil Co.	.....	660	660
The Heck Oil Co.	500	14,500	15,000
The Federal Oil & Gas Co.	1,190	4,800	5,990
Tuel & Thonen	60	464	524
Townsell, Bosquett & Co.	.....	1,030	1,030
Townsell, P. J., Oil & Gas Co.	.....	111	111
The Cameron Heat & Light Co.	221	.....	221
Transcontinental Oil Co.	500	.....	500
The Comet Oil & Gas Co.	1,500	5,000	6,500
Three Drillers Oil Co., et al.	123	.....	123
Trainer & Travis	300	1,200	1,500
Tait Brothers & Co.	1,060	.....	1,060
Trainer, J. E.	15	2,000	2,015
Triangle Oil Co.	85	.....	85
The American Oil Development Co.	7,865	.....	7,865
The D. C. Davis Oil Co.	648	.....	648
Trimble Oil & Gas Co.	125	.....	125
Tyler Oil Co.	1,055	.....	1,055
Thomas, Geo. E.	195	393	588
The Prospect Oil & Gas Co.	.....	6,700	6,700
Taylor & Dye Oil Co.	2	.....	2
Treat, E. M., Oil & Gas Co.	578	141	719
The Crude Oil Co.	1,902	2,126	4,028
The Wiser Oil Co.	867	8,805	9,672
The Jackson Oil & Gas Co.	40	139	179
	51,889	193,369	245,258

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189 Uniontown & McKeesport Oil Co.	40	40	80
Union Central Oil Co.	767	1,600	2,367
United Oil Co.	290	.....	290
United Oil & Gas Co.	200	3,300	3,500
Umpleby Oil Co.	117	.....	117
Umpleby Brothers	3	.....	3
University Oil Co.	300	.....	300
Valley Oil Co.	85	.....	85
Vesper Oil & Gas Co.	976	1,475	2,451
Valley Mills Oil Co.	150	150	300
Vickers Oil & Gas Co.	65	.....	65
Wright & Loper Oil Co.	900	.....	900
Williams & Cayton	185	845	1,030
Wilson Oil Co., et al.	23	150	173
Weston Carbon Co.	420	.....	420
Wilson, J. F.	.....	432	432
Weir, J. B.	3,080	.....	3,080

	Developed.	Undeveloped.	Total.
West Virginia Consolidated Oil Co.	530	.....	530
Wood Oil Co.	250	.....	250
Wabash Oil Co.	101	.....	101
Wilson & Swiger	.....	218	218
West Virginia Utilities Co.	6,490	4,705	11,195
Wickwire Oil & Gas Co.	.....	5,548	5,548
White Sand Oil Co.	377	23,175	23,552
White Top Oil Co.	190	.....	190
Washington Gas Co.	1,500	.....	1,500
Wyeth-Elson Oil Co.	200	.....	200
Washington Oil & Gas Co.	95	.....	95
Wasmuth Brothers	284	405	689
Wetzel, C. H.	.....	130	130
Walnut Run Oil Co.	175	400	575
Wallace Oil Co.	141	.....	141
Wait Oil Co.	455	.....	455
Whalen, Ahner & Alford	40	.....	40
Wetzel Natural Gas Co.	65	68	133
	18,494	42,641	61,135

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190 Columbian Carbon Black Co.	5,246	.....	5,246
Castlebrook Carbon Black Co.	563	45	608
Eastern Carbon Black Co.	1,988	.....	1,988
Johnston, J. E.	364	.....	364
McCutchen, G. E.	700	.....	700
Raccoon Gas Co.	437	938	1,375
Southern Oil Co.	22,486	10,778	33,264
Black & Walker	236	.....	236
Victoria Oil Co.	705	500	1,205
Grove & Parrish	397	.....	397
Allen, Virgil I. (Estate)	64	.....	64
Bailey Gas Co.	135	1,500	1,635
Berea Heat & Light Co.	6	.....	6
Bristol Oil & Gas Co.	227	.....	227
Buckhannon Fuel Co.	239	.....	239
Cather Gas Co., J. B.	150	350	500
City & Suburban Gas Co.	1,761	207	1,968
Clarksburg Light & Heat Co.	8,405	8,081	16,496
Fay Company	.....	450	450
Home Petroleum & Natural Gas Co.	251	.....	251
Jane Lew Light & Heat Co., The	40	2	42
Monongahela Valley Traction Co.	5,047	14,620	19,667
Moore, Herman	35	.....	35
Natural Gas Company of West Virginia	.....	12,407	12,407
Salem Natural Gas Co.	386	.....	386

	Developed.	Undeveloped.	Total.
Southern West Va. Oil & Gas Corporation	1,035	11,187	12,222
Troy Oil & Gas Co.	66	.....	66
West Union Gas Co.	155	212	367
Glenville Natural Gas Co.	200	.....	200
Travis, G. B.	8	460	468
West Va. Central Gas Co.	9,364	24,703	34,067
West Va. Heat & Light Co.	436	218	654
W. Va. Traction & Electric Co.	6,117	6,770	12,887
Carter Oil Co.	51,924	145,566	197,490
Philadelphia Oil Co.	.....	855	855
Hope Construction & Ref-ing Co.	.....	43	43
South Penn Oil Co.	136,497	466,629	603,126
Bennedum & Trees	530	.....	530
Alleen Oil & Gas Co.	1,800	.....	1,800
McIntyre Oil & Gas Co.	5,000	.....	5,000
Floyd & Bramer	600	7,400	8,000
Atlas Gas Corporation	600	.....	600
McKim Oil Co.	50	.....	50
Williams & Co.	108	.....	108
Gillespie, R. G.	4,619	1,113	5,732
Latty Oil & Gas Co.	207	.....	207
Libby-Owens Glass Co.	5,000	55,000	60,000
	274,184	770,044	1,044,228

Recapitulation.

Page 1	26,860	50,432	77,292
2	45,200	90,865	136,065
3	53,200	147,188	200,388
4	25,775	14,175	39,950
5	28,405	107,945	136,350
6	51,889	193,369	245,258
7	18,494	42,641	61,135
8	274,184	770,044	1,044,228
Grand totals	524,007	1,416,659	1,940,666

191 & 192 *General Summary of Acreage Held by Operators in West Virginia as Compared with Testimony of Mr. Nease.*

	Developed.	Undeveloped.	Total.
Testified by Nease as held by seven companies	689,305	1,866,720	2,556,025
Ascertained as held by other operators	524,007	1,416,659	1,940,666
Estimated held by operators not included in above	100,000	300,000	400,000
	1,313,312	3,583,379	4,896,691

Percentage Held by Operators Other Than the Seven Companies Without the Estimate of Those Unascertained.

Developed.	Undeveloped.	Total.
43.2	43.1	43.2

Percentage With the Estimate of Those Unascertained.

Developed.	Undeveloped.	Total.
47.5	47.9	47.9

193 PENNSYLVANIA EXHIBIT 55.

Offered at p. 1442 of Printed Record by Witness Wyer.

Smithsonian Institution Bulletin on "Natural Gas Production, Service, and Conservation."

GAS WASTE IN KELLY'S CREEK FIELD NEAR CHARLESTON, W. VA.

Two 4-inch lines on hillside, blowing at least 5,000,000 cubic feet of natural gas into the air in order to get oil. This is due to competitive conditions, carelessness in operation, and the popular attitude that natural gas is not worth saving.

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SMITHSONIAN INSTITUTION
UNITED STATES NATIONAL MUSEUM
Bulletin 102, Part 7

THE MINERAL INDUSTRIES OF THE UNITED STATES

NATURAL GAS: ITS PRODUCTION, SERVICE, AND CONSERVATION

BY

SAMUEL S. WYER
Of Columbus, Ohio

WASHINGTON
GOVERNMENT PRINTING OFFICE
1918

1622

FOREWORD.

Natural gas is the least appreciated, consequently the most abused, of the mineral resources in popular use. The issues involved are of direct concern to some ten millions of the inhabitants of the United States, and their range of influence does not stop even here; for they form a prominent feature in the nation-wide problem of fuel supply which may be solved effectually only through coordinated attention to the component parts. This problem science and technology, working together, can take the initiative in simplifying, by pointing the way and devising means for its solution, but of their own initiative, they are powerless to go further. The responsibility of initiative in carrying forward the actual process of solution rests with the public, and resting with the public is contingent, as a first requisite, upon public opinion genuinely alive to the situation. This condition of affairs, naturally, is most pronounced in industrial connections of the public service order to which the activities comprising the natural gas industry belong; and this particular situation, bad enough from environment, is further aggravated by characteristics inherent in the resource.

The public must look to remedying the situation or within a very few years lose the services of the resource already seriously impaired. The stimulus to action contributed in the form of technical discussions is inadequate and equally so that afforded in appeals to sentiment and sensationalism. The United States National Museum has undertaken the preparation of an exhibit designed to visualize the situation in its true bearing, and the normal order of precedence would be to follow this with publications drawing upon the exhibit. In view of the present emergency, however, with its effect on the question of fuel supply, it is deemed best not to wait upon ceremony but to publish the present paper by Mr. S. S. Wyer, without the delay which would otherwise occur.

The situation is too complex for any simple formula of remedy. It is not only complex but acutely critical as well, and needs all the light that can be thrown on it from all sides. This particular discussion sets forth the technical issues as viewed by a practical engineer who alone is responsible for it in a concise, readable presentation which makes it a distinct contribution toward clarifying the situation.

C. G. GILBERT,
Curator, Division of Mineral Technology,
United States National Museum.

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NATURAL GAS: ITS PRODUCTION, SERVICE, AND CONSERVATION.

By Samuel S. Wyer.
Of Columbus, Ohio.

FUNDAMENTAL PRINCIPLES OF NATURAL GAS PRODUCTION.

HOW NATURAL GAS IS MINED AND SERVED TO THE CONSUMER.

The first step is the securing of the lease or right to prospect for, reduce to possession, remove and market natural gas. This lease must usually be secured, held, and paid for, for a number of years—on the optimistic but unproven faith that it may contain gas—prior to beginning actual development work.

The unknown underground supplies of natural gas are found and reduced to possession by drilling down from the earth's surface. To protect the hole, an iron pipe—called a "casing"—is driven down into the rock formation always found above the gas-bearing sand rock. A plugging device known as a "packer" is fastened in the casing or hole in the rock, immediately above the gas formation, and the gas by virtue of its inherent expansive tendency then comes to the surface—usually about one-half mile above—through tubing, as shown on page 8, and forces itself into the transmission lines, when it then may continue by its own expansive force to travel on toward the consumer.

As the gas travels the pressure must drop, for the reasons given on page 10, and this necessitates the installation of gas compressors, whose function is to recompress the gas, increasing thereby its pressure, so that it will continue to travel through the transmission lines. From the compressing station the gas then goes to the consumer. When the gas reaches the distributing plant it passes into the medium pressure lines in the city and the pressure is then in turn reduced to the low-pressure lines, where it travels through the mains at probably 5-ounce pressure to the square inch—this, of course, constantly decreasing as the consumer's fixtures are approached—through the service cock, service line, consumer's meter, consumer's piping, and ultimately is burned at the consumer's fixtures.

These steps present an unbroken chain of service features, from the reserve acreage in the field—that must be carried and paid for in order to permit of future drilling operations, and, therefore, future service—to the consumer's fixtures, with this additional feature, that when the gas passes the consumer's meter it is reduced to possession

by him, becomes his personal property, under his absolute control, and he can do with it what he pleases.

DEFINITION OF LEASE.

A natural gas lease is a contract for a consideration establishing a vested right to enter upon a definitely described parcel of land, for a determined period, to prospect for, reduce to possession, remove and market natural gas. The vested right is the crux of the whole matter, and it is immaterial whether the instrument creating it is called a "lease," "contract," "grant," or "deed of conveyance."

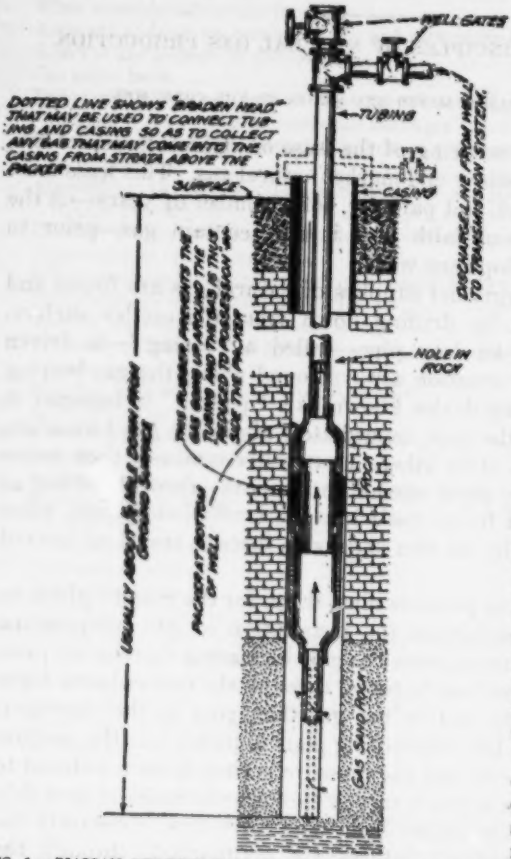
WELL GATES
DOTTED LINE SHOWS "BURDEN HEAD" THAT MAY BE USED TO CONNECT TUBING AND CASING SO AS TO COLLECT ANY GAS THAT MAY COME INTO THE CASING FROM STRATA ABOVE THE PACKER
TUBING
SURFACE
CASING
DISCHARGE LINE FROM WELL TO TRANSMISSION SYSTEM
HOLE IN ROCK
THIS RUBBER PREVENTS THE GAS FROM GOING UP AROUND THE TUBING AND THAT GAS IS THUS REDUCED TO POSSESSION AT THE PACKER
USUALLY ABOUT 2,000 FEET DOWN FROM GROUND SURFACE
PACKER AT BOTTOM OF WELL
GAS SAND ROCK

FIG. 1.—DIAGRAM SHOWING HOW NATURAL GAS IS REDUCED TO POSSESSION.

In a given tract of land it is always a matter of doubt to what extent, if any, mineral may exist in paying quantities, until very considerable development work has been performed, which requires in most instances large expenditure of capital. For this and other reasons, a custom long ago arose for the owner of supposed mineral land to grant to a mine operator the right to enter upon the land and search for and extract mineral, and the form which the contracting parties pretty generally adopted to express their agreement was a "lease," which purported to entitle the "lessee" to occupy such part of the premises as was necessary to carry on his mining operations, and to use, mine, and extract the minerals therefrom. (Lindley on Mines, ed. 3, p. 2134.)

RESERVE ACREAGE.

Based on the United States Geological Survey statistics for 1916, natural gas producers in this country carry an average of 313 acres

for each producing well, in their attempt to provide as far as possible continuity of service to their customers. However, this average of 313 acres will vary with different fields and localities. In West Virginia the United Fuel Gas Co. in 1917 carried 1,252 acres to the producing well, as shown on page 24. From this it is evident that not every farmer—that is, landowner—can have a producing well, even though his farm may be located in the center of producing territory. While natural gas wells are frequently drilled on tracts of less than an acre in area, by small producers intent only on getting the gas out in the fastest possible manner, without any regard to future service, the future continuity of service to the gas-using public is possible only by the carrying of reserve acreage for future drilling operations.

DISTINCTION BETWEEN ACREAGE LEASE RENTALS AND GAS WELL ROYALTIES.

The general custom of the natural gas business is to pay a lease rental based either directly on indirectly on the acreage of the tract that is controlled. The natural gas acreage statistics of the United States Geological Survey for 1916 show that—

5 per cent of acreage is owned in fee.
8 per cent of gas rights are owned in fee.
87 per cent of gas rights are merely under lease.

This acreage rental covers a twofold object—

1. Gives the gas company the right to enter the particular tract of land for exploration purposes.

2. Pays the farmer—that is, landowner—for any gas that might be found on such tract, even though such gas would be removed by drainage through to wells located on adjacent tracts.

Well royalty is merely compensation for particular wells drilled, and replaces the acreage rental that prevailed prior to the drilling of the wells. The well royalty for a particular tract is usually larger than the aggregate of the acreage rental because of the damages and inconvenience to the farmer in having wells and their appurtenances located in his fields.

It is not ordinarily appreciated that the total amount of money paid for "acreage rental" is larger than for "well royalties." Thus, the acreage rental of the United Fuel Gas Co. for the year 1917 was 80 per cent of the total annual sum spent for gas rights.

FUNDAMENTAL CONCEPTION OF GAS.

Gas is a fluid composed of a large number of molecules which are vehicles of energy continually in motion and having an inherent tendency to get farther and farther apart. The range of motion

of the molecules is limited only by the volume of the closed containing vessel in which they constantly move to and fro. Every molecule possesses the inherent power of energy and is eternally energetic within itself. That is, the molecules are in a state of constant bombardment against each other and against the sides of the containing vessel. The most distinguishing characteristic of gas is its universal property of completely filling an inclosed space.

CAUSE OF GAS PRESSURE.

Gas pressure is the result of the combined efforts of all the moving molecules in the gas trying to get farther and farther apart; that is, a mass of gas inclosed in a vessel expands and fills it, and, being restrained from further expansion, it exercises a pressure against the walls of the vessel. This pressure is the same in all directions on equal areas of surface. Not only is every gas molecule eternally energetic but its energy may be augumented or retarded by external conditions. Contracting the volume of gas increases the intensity of its internal molecular motion and therefore increases its pressure. Conversely, expanding the volume of a given mass of gas decreases the intensity of its internal molecular motion and therefore decreases its pressure. That is, with a given mass of gas any increase in volume of containing vessel will give the molecules more range of motion and thereby lower the pressure. Thus, if a part of a given mass of gas is removed from a closed vessel or reservoir the remaining mass of gas will expand instanter and keep the vessel or reservoir filled, but at a lower pressure.

WHAT MAKES GAS FLOW.

The inherent tendency of gas to expand is the basic cause of gas flow. Gas flow in pipes or underground reservoirs can not take place except between openings of higher, to openings of lower pressure; that is, flow can be obtained only by sacrificing pressure. This is in accordance with the universal natural law that as long as energy of any form undergoes no transformation it tends to gravitate to a lower degree of intensity—that is, becomes more stable and approaches a universal level of stable equilibrium. Thus, water always seeks the lowest level, and confined gas always tends to expand to lower pressures. Even where gas compressors are used to increase the pressure by contracing the volume, the gas is not pushed through the pipe like a plug of incompressible fluid, like oil or water, but goes through by virtue of the increased expansive force resulting from the higher pressure.

DEFINITION OF NATURAL GAS.

Natural gas is a highly combustible gas made by a secret process of nature. It is not a chemical compound—as popularly supposed—

but a mechanical mixture of several combustible and diluent gases and vapors thoroughly diffused through each other, the number and exact proportion of the various crude natural constituents varying for the different localities and somewhat during the working lives of individual wells.

The term "casing-head gas" is applied to a natural gas that flows from oil wells, coming out between the casing and tubing. It is collected by means of a metal head—called "braden-head"[1]—connecting the casing with the tubing, as shown by the dotted lines at the top of fig. 1. The term "braden-head gas" is sometimes used synonymously for casing-head gas.

DEFINITION OF "MECHANICAL MIXTURE."

This is a mixture where two or more substances are brought together in a thoroughly commingled state, without, however, any of the constituent substances losing their individual identity. The various vapors and gases going to make up natural gas are merely intermingled as mechanical mixtures. Another very common illustration is atmospheric air, where water vapor and the gases oxygen and nitrogen are merely mixed in the form of a mechanical mixture; that is, the water vapor has undergone no chemical change and the oxygen and nitrogen have undergone no chemical change by the mixture.

DEFINITION OF TERM "VAPOR."

This word literally means a warm exhalation. A vapor is the gaseous state of a substance which at ordinary temperature exists as a solid or liquid; that is, the vapor is the result of the action of heat on a solid or liquid. On removal of the heat the vapor will return to its former solid or liquid state. When a liquid, by the action of heat, goes into a vapor or gaseous form it is said to vaporize or evaporate, the meaning of these two terms being the same. The most common form of vapor is the moisture always present in greater or less degree in the atmospheric air.

GASES AND VAPORS DISTINGUISHED.

A vapor is an aeriform substance in the gaseous state at any temperature below the critical point, the critical point being the line of demarcation between a vapor and a gas. The temperature of fluid at the critical point is the critical temperature, and the pressure which at this critical temperature just suffices to condense the gas to the liquid form is called the critical pressure. A vapor can be reduced to a liquid by pressure alone, and may exist as a saturated

[1] Named after its designer Mr. Glenn T. Braden.

vapor in the presence of its own liquid. A gas is the form which any liquid assumes above its critical temperature, and it can not be liquefied by pressure alone, but only by its combined pressure and cooling. All vapors are gases, but not all gases are vapors. The difference between vapors and gases may be summarized as follows:

Aeriform fluids.

Vapor.	Gas.
Below its critical temperature and pressure.	Above its critical temperature.
Can be condensed by pressure alone.	Can be condensed only by both pressure and cold.

Gasoline found in natural gas always exists there in the form of a vapor, while methane, for instance, in natural gas exists only as a gas.

NATURAL GAS MAY BE WET OR DRY.

Natural gases coming from the ground may be classed—according to their gasoline vapor content—into two main groups, namely:

1. *Wet gas.*—This is gas intimately associated with oil, usually produced with oil, and is ordinarily known as casing head natural gas.

2. *Dry gas.*—This is gas not intimately associated with oil, but may nevertheless contain gasoline vapors. The term "dry" does not refer to water vapor that may be carried by the gas, but rather to the gasoline vapor, and, furthermore, this is a relative term since a strictly dry gas would be one containing no gasoline vapors.[1]

WRONG IMPRESSION OF WORD "NATURAL."

While natural gas is a natural product made by nature, it is no more natural than other minerals, like coal, oil, or iron ore. The word "natural" came into common use probably as contrasted with manufactured gas, and the use of the word appears to have given a fallacious impression that natural gas was a free and unlimited resource. Merely being made by nature does not mean that a substance is cheap and of low value. Natural gas is a natural resource, which men have learned to use for the satisfaction of their wants. The misconception regarding the position of natural gas has arisen from failing to appreciate that man creates no new matter and can merely get the materials of nature ready for consumption. Food, clothing, wealth in all its forms, are derived originally from nature. The forces of nature, working through the ages, have created things which mankind needs. Human effort expended on these products of nature, converts them into forms which are usable.[2]

[1] For further discussion, see Bureau of Mines Bulletins No. 88 and No. 120.

[2] Suggested by Ely's Outlines of Economics.

NATURAL GAS A MINERAL.

Broadly, the word mineral means the inorganic materials of which the earth consists. "The word minerals in the popular sense means those inorganic constituents of the earth's crust which are commonly obtained by mining or other process for bringing them to the surface for profit." That is, the term "mineral" is not, *per se*, a term of art or trade, but of general language, and in addition to its broad scientific meaning is also used in a commercial sense where it may include any inorganic substances found in nature, having sufficient value, separated from its condition as a part of the earth, to be mined.

Natural gas is now universally classed as a mineral. However, on account of its adventitious origin, migratory habits, and fugitive tendencies, it is regarded as a mineral with special attributes. Since it is a mineral, it is, therefore, a crude product. As so aptly stated by the United States Supreme Court, "Natural gas is a crude mineral, not advanced in value or condition by refining or grinding or by any other process of manufacture."[1]

ORIGIN OR FORMATION OF NATURAL GAS.

How, when, and where the constituents of natural gas were formed is not definitely known. For our purpose we need not bother about the various theories that have been propounded regarding the origin or formation of petroleum generally or natural gas constituents in particular. That is, whether these constituents originated from cosmic, organic, inorganic, animal, vegetable, volcanic, animal bacterial, plant bacterial, diatomic, or fatty algal sources is not germane. Neither is the matter of adventitious and migratory or indigenous and accumulative relationship with regard to any geological formation of vital importance.

The incontrovertible facts are that we have in natural gas a crude natural substance made up of mixtures of widely varying constituents—even though we may not know how these mixtures were thrown together—for different natural gas fields in the United States. Some of these natural gases are wet, while others are dry; some are high in heating value, while others are low, and some are heavy, while others are light in weight.

STARTING POINT OF GAS ACTIVITY.

As far as temperature is concerned, gas activity begins at a point 460° below zero on the Fahrenheit scale, and as far as pressure is concerned, it begins at the point of absolute vacuum, or 14.7 pounds below atmospheric pressure at sea level. Neither point has ever

[1] United States *versus* Buffalo Natural Gas Fuel Co., 172 U. S., p. 389.

been reached by man's physical senses, but both form the bases from which all gas volume calculations must be made as shown on pages 15 and 16.

BAROMETRIC PRESSURE.

Atmospheric pressure is measured by a barometer—usually in inches of mercury, 1 inch of mercury equaling 0.49 pound to the square inch pressure—and is synonymous with barometric pressure. Sea level is the basis from which atmospheric pressures are reckoned. At that point dry air at 32° Fahrenheit exerts a pressure of 14.7 pounds to the square inch.

This pressure varies with altitude and temperature, the pressure decreasing with an increase in altitude or temperature. 14.4 pounds represents a fair average barometric pressure for most natural gas using communities.

GAGE PRESSURE.

This is simply the pressure indicated by a pressure gage. Two general classes of gages are used for measuring gas pressure:

1. *Spring gages.*—Where the effect of the pressure exerted against some form of spring is made to move a pointer over a graduated dial or scale.

2. *Fluid gages.*—Where the effect of the pressure is indicated by the height of the column of fluid in a U-shaped tube. One side of the U-shaped tube is open to the atmosphere and the other is attached to the pipe where the pressure is to be measured. The gas pressure in this pipe then lowers the fluid in one side of the tube and raises it in the other. The total difference in the heights of the fluid on the two sides represents the total fluid pressures. When no pressure is applied to such a U tube gage other than the prevailing atmospheric pressure, the liquid will stand at the same level in both tubes.

The pressures in natural gas distributing plants are almost universally measured in ounces to the square inch, while the pressures in manufactured gas distributing plants are measured in inches of water, 1 ounce equaling 1.73 inches of water.

Where the word pressure occurs in ordinances or rules it invariably means gage pressure.

ABSOLUTE PRESSURE.

This is the sum of the gage pressure and the barometric pressure. Thus, if the gage pressure is 4 ounces—equaling 0.25 pound—and the atmospheric pressure 14.4 pounds to the square inch, the absolute pressure will be 14.65 pounds to the square inch, as shown on p. 15. This must be used in all gas calculations dealing with change of volume due to effect of pressure.

Failure to appreciate that the absolute pressure, rather than merely the gage pressure, must be used when computing the effect of pressure on gas volume, or heating value content, has been responsible for most of the misunderstanding regarding the effect of variation in gage pressure on gas quality and gas service.

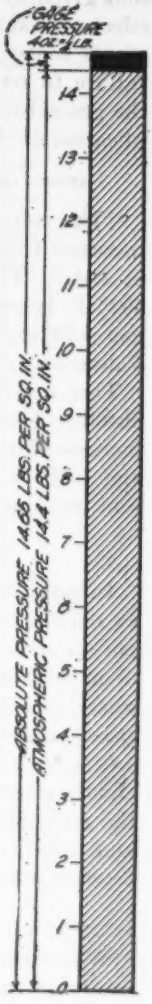

FIG. 2. — DIAGRAM SHOWING RELATION OF ATMOSPHERIC AND GAGE PRESSURE.

DIFFERENTIAL PRESSURE.

This is simply the difference between the pressure at the inlet and outlet of a gas line. Thus, if the inlet gage pressure of a gas line were 50 pounds and the outlet gage pressure 10 pounds the differential pressure would be 40 pounds. In gas transmission it is necessary to have a differential pressure in order to secure driving power to force the gas through the line. That is, the differential pressure is the pressure that is lost in overcoming the friction of the gas moving through the line.

EFFECT OF PRESSURE ON GAS VOLUME, KNOWN AS BOYLE'S LAW.

There is a definite relationship existing between the volume and pressure of natural gas. That is, when the gas is compressed or allowed to expand, it approximately follows Boyle's law. This law may be stated as follows: "The volume of a gas at constant temperature varies inversely as the absolute pressure to which the gas is subjected; or, what is the same thing, the product of the absolute pressure and the volume of a given quantity of gas remains constant."

Thus, if the volume is doubled, or one-half of the gas is removed from a fixed reservoir, the absolute pressure will be reduced one-half. Conversely, if the absolute rock pressure in a fixed reservoir is reduced to one-half, the volume of gas remaining compressed in that reservoir will be reduced to one-half.

It has been the universal custom of the natural gas industry to disregard the small deviation of natural gas from Boyle's law and in measuring computations to assume that the gas follows the law exactly. Tests made on the West Virginia gas indicate that the per cent of deviation increases with the pressure. That is, while there is no perceptible deviation at pressures under 15 pounds, at 150 pounds the deviation would be about 6 per cent. That is, the

actual expansion of gas in lowering the pressure from 150 pounds down to less than 10 pounds would be about 6 per cent greater than that given by literal application of the law. This has the practical effect of making leakage in main lines and natural gas distributing plants sometimes seem considerably less than it actually is, due to failure to recognize that in expanding from high pressure to low the gas actually increases in volume more than the exact literal application of the law would give.[1]

EFFECT OF TEMPERATURE ON GAS VOLUME, KNOWN AS CHARLES' LAW.

"The volume of a given mass of any gas under constant pressure increases from the freezing point by a constant fraction of its volume at zero." This starts from the absolute zero of the gas, which is 492° F. below freezing, as shown at the right. In other words, the gas will expand 1/492 of its volume at 32° F. for each degree Fahrenheit rise of temperature.

This makes the change in volume directly proportional to the absolute temperature and means that approximately each 5° F. increase in temperatures makes an increase of 1 per cent in volume and each 5° F. decrease in temperature makes a decrease of 1 per cent in volume. For specific application of this see page 471.

GAS SAND OR GAS ROCK.

In no case is the gas found in rooms, caverns, or large crevices, as popularly supposed. "The oil and gas sands are simply very porous rocks which contain not only one great cavity, but millions upon millions of small or microscopic cavities, so that the oil, gas, water, or all three together, it may be, occupy these numerous little spaces, and thus saturate the rock just as water does a piece of cloth or a sponge when dipped into the same. The larger these pores are, and the greater the volume they occupy in proportion to the volume of the rock mass, the greater will be the contained oil or gas supply, and this proportion in fairly good producing sands, usually varies between one-fifth and one-tenth."[2]

DEFINITION OF ROCK PRESSURE.

When nature generated or deposited the natural gas in the rock reservoir—made up of the microscopic cavities between the sand grains—a fixed amount of gas was placed in a fixed inclosed space. The pressure in the rock—called "rock pressure"—was the result of the pressing into this fixed rock space of a larger volume of gas than the mere free air capacity of this rock reservoir. The degree of compression employed by nature in the formation process deter-

[1] Deviation of Natural Gas from Boyle's Law, by Robert F. Earhart and Samuel S. Wyer. Transactions American Society Mechanical Engineers, vol. 38, p. 285.
[2] I. C. White, West Virginia Geological Survey, vol. 1, p. 155.

mined the intensity of the resulting pressure in the reservoir; that is, a high degree of compression produced a high rock pressure, and a low degree of compression produced a low rock pressure. Typical rock pressure decline curves are shown in figures 3 and 4.

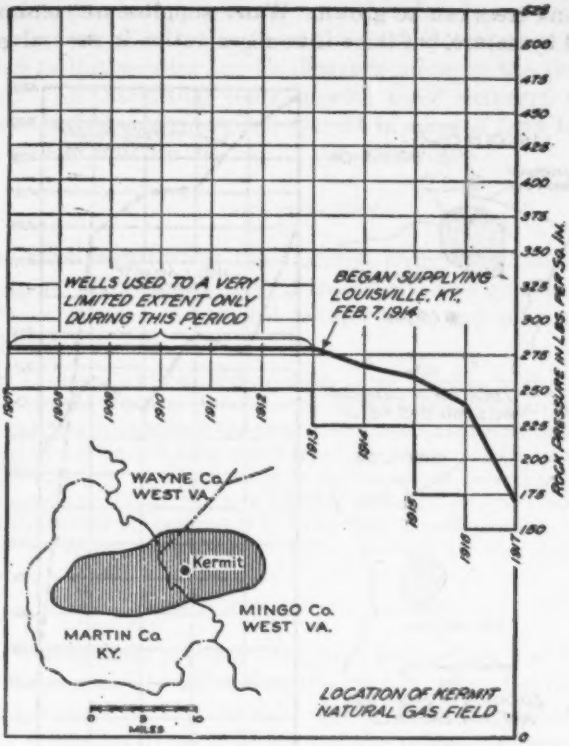

FIG. 3.—DECLINE IN ROCK PRESSURE OF NATURAL GAS WELLS OF THE UNITED FUEL GAS CO. IN KERMIT FIELD IN KENTUCKY AND WEST VIRGINIA.

WHY ROCK PRESSURE AND VOLUME MUST DECLINE.

The rock pressure and volume must decline as gas is removed, because in the removal of the deposit of gas we are confronted with the following:

1.—A fixed volume of the reservoir.

2.—A fixed amount of gas inclosed in this fixed reservoir.

3.—A certain rock pressure resulting from the contraction of the gas volume into the fixed reservoir.

Now, if a part of this fixed volume of gas is removed by tapping the reservoir from the surface of the earth, the remaining gas volume

expands and keeps the reservoir completely filled, but at a lower pressure. Rock pressure decline is therefore inevitable whenever any gas is removed.

REGENERATION.

Food and trees can be grown. Water supplies are constantly replenished by nature, but there is no regeneration in natural gas; and

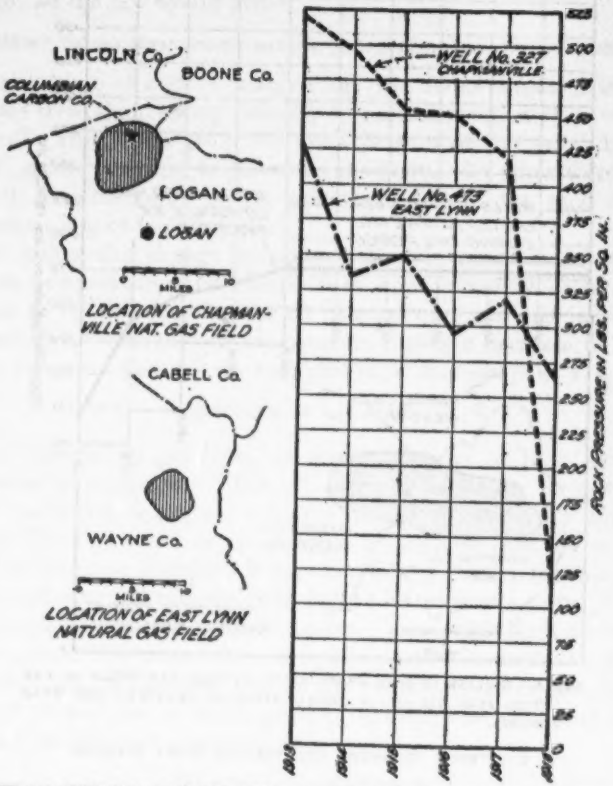

FIG. 4.—DECLINE IN ROCK PRESSURE OF NATURAL GAS WELLS OF THE UNITED FUEL GAS CO. IN EAST LYNN AND CHAPMANVILLE FIELDS, W. VA.

when the gas is once used it is gone forever. While no one knows exactly how the natural gas is formed, yet enough facts are known about it to indicate that nature's process was a very slow one. It has taken millions of years to make the present concentrated supplies, and even though gas should now be formed in some parts of the earth's crust, the rate of formation will be so slow as to make such new gas pools of no interest or economic value for centuries, if ever.

STORAGE OF NATURAL GAS.

Storage facilities for natural gas are not commercially feasible in the field nor at the delivering end of the transmission line, except the very limited use of existing gas holders in distributing plants. The large variation in service demands must therefore be met by the wells and reserve acreage. That is, the entire field operations must be subordinated to the peculiar service demands made on the natural gas company. An interesting contrast with these stringent operating conditions is the large storage equipment in acres of tank farms that may be used to equalize the load in the oil industry.

LIMITS OF GEOLOGY.

While earth structure is the essential element in the accumulation of large quantities of natural gas or oil, geological science is a directional indicator and hazard reducer only, and not a guarantor of commercial results.

Geology answers that by careful attention to her precepts, much of the waste that characterized the first three decades of the search for petroleum can be avoided, but that it is beyond her powers to foretell absolutely as to whether any particular boring will yield either oil or gas in commercial quantity. The careful geologist can eliminate many of the factors of uncertainty, and thus limit the search to regions having a peculiar geological structure where experience has shown that the occurrence of oil and gas is most probable, but further than this geology can not go, and no skillful geologist has ever claimed otherwise.[1]

LIMITS OF UNDERGROUND RESERVOIRS.

There is absolutely nothing fixed from the surface, and while surface conditions may be indicative, the question of underground location can be established by the drill alone. Even the presence of gas sand is not necessarily an indication of the presence of gas, as many dry holes show the full sand formation, without any gas in the sand. The dry holes shown in the map of the Triple State Field on plate 7 indicate a typical field situation, emphasizing the inability to determine underground limits except by drilling a hole.

OPEN OR NATURAL FLOW.

The courts have used the term "natural flow" synonomously for the engineering term "open flow," both, however, meaning exactly the same thing.

The term "natural flow" necessarily means the entire volume of gas that will issue from the mouth of a gas well when retarded only by the atmospheric pressure. (Appellate Court of Indiana, 66 N. E., p. 782. Richmond Natural Gas Co. *versus* Enterprise Natural Gas Co.)

[1] I. C. White, West Virginia Geological Survey, vol. 1, p. 158.

The marked difference between the open flow of a gas well and the actual flow that may be obtained under routine operating conditions is emphasized in the next section.

MISLEADING WELL CAPACITY.

The natural gas well capacities that are given to the public are always the open flow capacity; that is, the capacity of the well in 24 hours when discharging freely into the atmosphere with no back pressure at all. This is misleading, and comes far from representing the true service capacity or true gas delivery capacity under routine operating conditions, of any gas well, because:

1. The first open flow measurements, which are usually the ones advertised in the newspapers, are nearly always made by the drillers, who do not have the facilities or skill to make an accurate test, and the errors are invariably on the side of a capacity larger than the actual facts. The volume is determined immediately after the well comes in, and is therefore greater than it would be several days afterward, on account of the fact that the well has not been drawn upon.

2. In routine operations of natural gas wells it is not possible to keep a well in service 24 hours, day in and day out. For various operating reasons, such as repairs, salt-water troubles, etc., it is necessary to rest wells at intervals. For this reason, the actual operating period of a well will be, on an average, very much less than 24 hours a day.

3. It is not feasible to maintain atmospheric pressure conditions in the pipes into which the wells discharge, but, on the contrary, the pressures are very much higher than atmospheric pressure. For this reason, the wells must discharge against considerable back pressure, thus retarding the amount of gas that will go out.

4. Based on actual operating tests, it has been determined that 25 per cent of the open flow capacity is about all that can be delivered from the average natural gas well. It must also be borne in mind that the open flow capacity will constantly decrease, with the removal of gas from the well.

5. As the rock pressure declines it will be necessary to install compressing stations in order to transmit the gas into and through the main transmission line.

6. After the compression station has been installed, the further inevitable decline in rock pressure will lower the capacity of such station, as shown on page 29.

MIGRATORY AND FUGITIVE NATURE OF NATURAL GAS.

Natural gas has no fixed position under any particular portion of the earth's surface. On account of its inherent tendency to expand it has the power, as it were, of self transmission and is capable of flow-

ing from place to place in the underground reservoir, or of being drawn off by wells penetrating the natural reservoir at any point. Therefore, when one owner of the surface overlying the common reservoir exercises his right to remove natural gas, the supply in the reservoir will be decreased and the amount available to other owners of the surface in contiguous territory must inevitably diminish.

EXTENT OF NATURAL GAS UNDERGROUND DRAINAGE.

Gas is the most uncertain, fluctuating, volatile, and fugitive of all mining properties. It lies far below the surface, beyond the control of human will and beyond the reach of any legal process. On account of the characteristics just mentioned it is impossible to know at what distances drainage takes place. This depends on the unknown character of the sand and whether a well 500 feet or 1,000 feet distant would drain natural gas from an adjacent tract is largely a matter of conjecture and surmise.[1]

QUALITY AND QUANTITY OF NATURAL GAS FIXED BY NATURE.

The quantity is always uncertain and the quality may vary through a small range for the different fields. However, it is not commercially feasible to attempt to correct variation in quality by any artificial means and furnish a gas that is uniform, as may be done in an artificial gas plant, for the simple reason that the cost of doing this would be much more than the additional worth of the service under such conditions.

SCARCITY OF NATURAL GAS.

Natural gas is an exhaustible resource that when once used is gone forever. Every time a natural gas company sells 1,000 cubic feet of gas it is selling a part of its property. Furthermore, the number of natural gas consumers is increasing faster than the number of producing wells, thus placing an additional burden on each well, and the wells that are being drilled at the present time have a lower average capacity than wells that were drilled several years ago, in this way making less gas available.

The decline in average acres land held per natural gas well and average delivering capacity per natural gas well for the entire State of West Virginia is shown on page 22.

The decline in number of acres for a natural gas well of the United States Steel Corporation, operating under the name of the Carnegie Natural Gas Co., in West Virginia, is shown on page 23.

The decline in number of acres natural gas land for each well of the United Fuel Gas Co. is shown on page 24.

[1] Paraphrased from Huggins *versus* Daley, 99 F. R., p. 606, and Hall *versus* South Penn Oil Co., 71 W. Va., p. 82.

For another operating company representing nearly 40 per cent of the State's production we have the following:

1. Number of acres natural gas land owned to a domestic consumer decreased from 3 acres in 1910 to 2 acres in 1917.

2. The average open flow capacity of new wells drilled declined from 1,200 M [1] in 1913 to 700 M in 1917.

3. The average annual production to a well declined from 3,600 M in 1910 to 2,200 M in 1917.

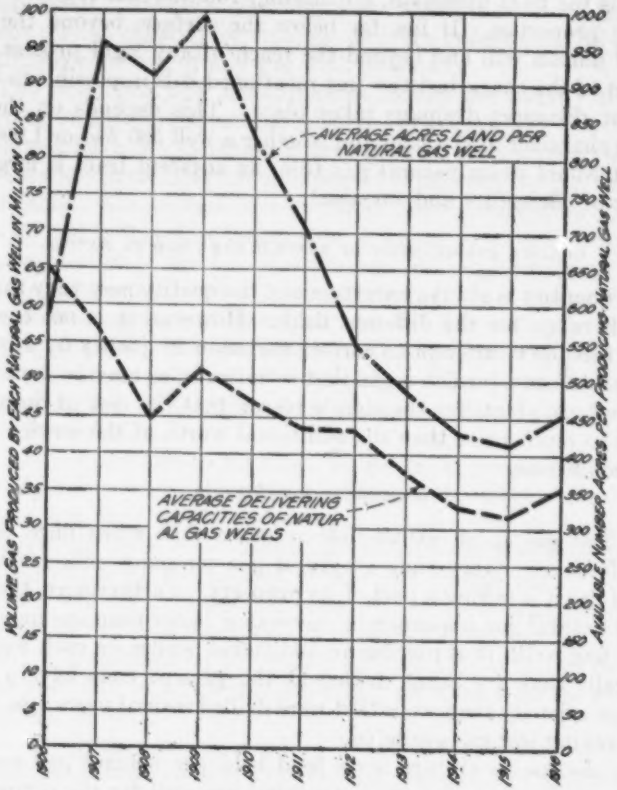

FIG. 5.—DECLINE IN WEST VIRGINIA NATURAL GAS RESOURCES, BASED ON DATA COMPILED BY THE UNITED STATES GEOLOGICAL SURVEY.

4. The number of domestic consumers that could be served by each producing well declined from 250 in 1910 to 170 in 1917.

5. Simultaneously with the above decline, the average annual gas service demands to the domestic consumer increased from 110 M

[1] The letter "M" represents "1,000 cubic feet," the unit of gas measurement.

cubic feet each year in 1910 to 153 M cubic feet each year in 1917. The demands for West Virginia natural gas are emphasized elsewhere.

NATURAL GAS SERVICE IS BASED ON A NONCREATABLE AND NONREGENERATIVE MINERAL.

The natural gas business is unique in that it is the only public utility service that does not, and in fact can not, create the basis feature of the service that it renders to the public. Manufactured

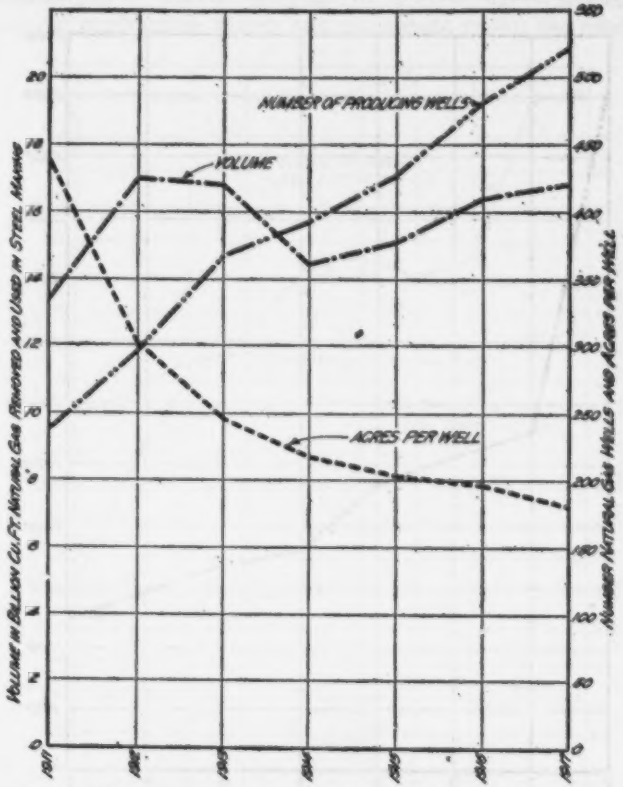

FIG. 6.—USE OF WEST VIRGINIA NATURAL GAS FOR STEEL MAKING, BY UNITED STATES STEEL CORPORATION.

gas companies merely produce their gas from the raw fuel that they can buy in the open market; transportation agencies, like railroads or street railways, can easily create the motive source of their service; water utilities have their water supply constantly replenished by nature; intelligence transmission utilities, like the telephone and telegraph, can easily create the primary source of their service. However, the natural gas industry is alone in depending entirely on

the caprice of nature for first the finding, and secondly the continuity of the supply of its primary source of public utility service.

NATURAL GAS SERVICE AND OIL BUSINESS DISTINGUISHED.

Gas can not be gathered, stored, or transported in the same manner as oil. If found in sufficient quantity, it is turned from the well into the line and the pressure at the mouth of the well is the motive power by which it is driven through the line to the consumer miles away. If the pressure at a given well is much below that in the line with which it is connected, the gas from that

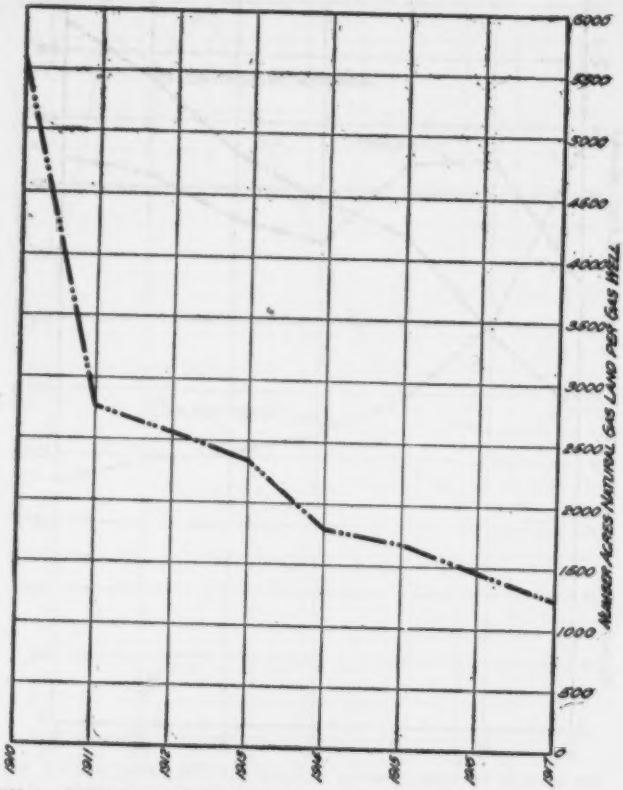

FIG. 7.—DECLINE IN NUMBER ACRES AVAILABLE NATURAL GAS LAND RESERVED FOR EACH NATURAL GAS WELL OF THE UNITED FUEL GAS CO.

well can not enter the line, but will be driven back by the superior force it encounters at the point of connection. For this reason, a well, producing gas in sufficient quantity to be profitably utilized, if there was a market for it near at hand, may be entirely valueless if its product must find a market at a distance too great to justify its transportation by a line of its own. In an oil district each well, no matter how large or how small its product may be, is separately operated, and a well may be profitably operated so long as its yield

pays more than the cost of producing the oil. In a gas district this is impracticable. The product of many wells is gathered into one line, so long as the pressure is sufficient. When the pressure in any one falls below the standard necessary for purposes of transportation, that well must be turned off. Its product can not be transported separately,[1] and unless it can be used near by, it is valueless. (Pennsylvania Supreme Court: McKnight *versus* Manufacturers Natural Gas Co., 146 Pa. St., p. 185.)

DRYING NATURAL GAS.

Natural gas as defined on page 10 is made up of a mechanical mixture of condensible vapors and permanent gases; the condensible

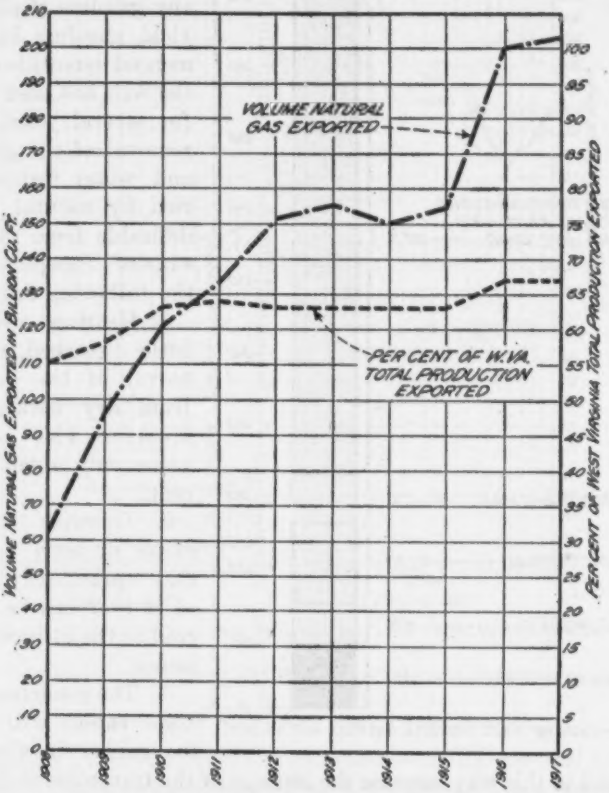

FIG. 8.—NATURAL GAS EXPORTED FROM WEST VIRGINIA.

constituents consist of gasoline vapor and water vapor. In the transmission of the gas, due to changing temperature and pressure

[1] Gas compressors can, of course, be installed so as to increase the pressure of the gas to permit its delivery into a line. The operating cost of this, however, may be much more than the market value of the gas. This, of course, is a very pointed illustration of the fundamental fact that in order to make gas conservation possible it must be made worth saving.

conditions, part of these vapors are condensed and then precipitated in the form of a liquid, and will give trouble in choking up the line, and the water may freeze, closing the line entirely.

The gasoline will soften and decompose the rubbers in the couplers. This is due to the solvent action of the gasoline on the rubber, and the immediate effect will be to cause the joints to leak, thereby greatly increasing the leakage loss.

The general tendency of natural gas is to become wetter as the well becomes older, and, therefore, natural gas from a new well that may be so dry as not to yield any gasoline at all, may yield gasoline in commercial quantities after the well has been in use for several years. The removal of the gasoline and water vapor carried by natural gas is desirable from the consumers' viewpoint for the following reasons:

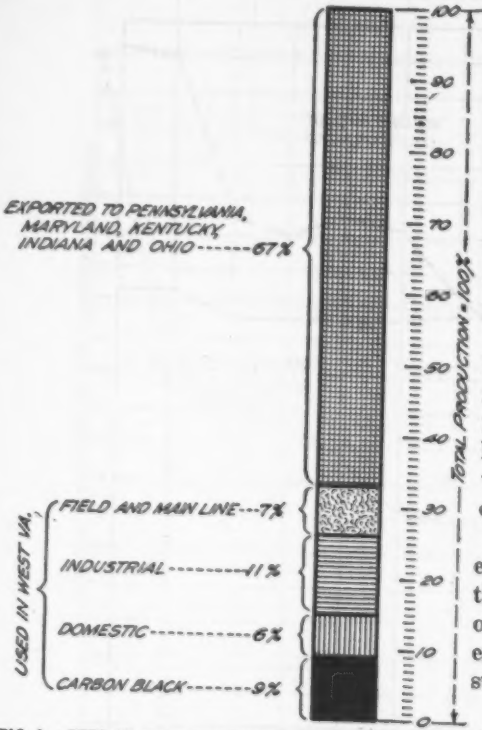

FIG. 9.—USES OF WEST VIRGINIA NATURAL GAS IN 1917.

1. Heating value is little disturbed, the removal of the gasoline from dry natural gas lowering the heating value only about 2 per cent.

2. Gasoline vapor exists in such a form that practically none of it ever can be delivered to the ultimate consumer.

3. The condensed gasoline vapors will injure the rubber in the couplers and in this way increase the leakage of the transmission line.

4. The condensed water vapor will freeze, causing interruption of service, or disturbed and fluctuating pressure conditions.

5. The removal of water and gasoline by blowing the drips results in a large waste of natural gas.

6. The drying of the gas tends to stabilize the gas service by decreasing line troubles.

Similar conclusions have been presented by the United States Geological Survey, on pages 645 and 646, in Natural Gas Statistics for 1916, and in Bulletin No. 120, page 11, of the United States Bureau of Mines.

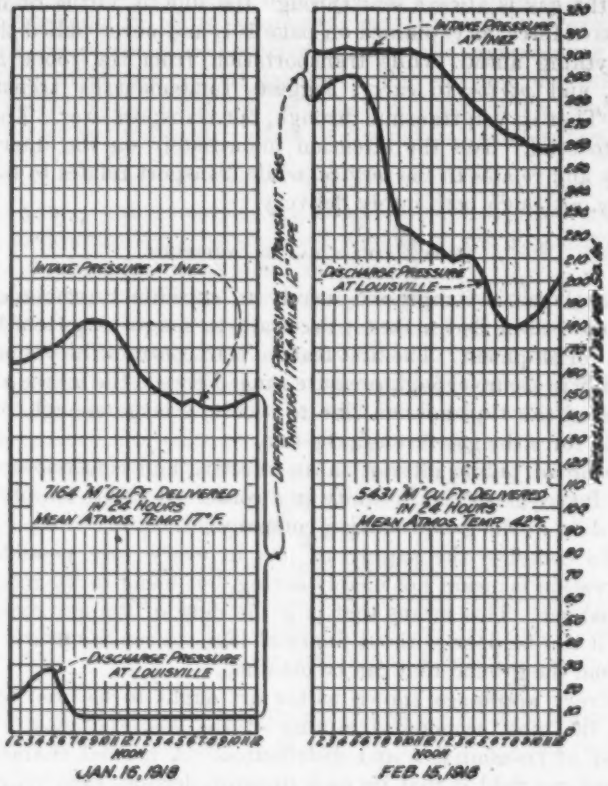
INTAKE PRESSURE AT INEZ
DISCHARGE PRESSURE AT LOUISVILLE
7164 M CU. FT. DELIVERED IN 24 HOURS MEAN ATMOS. TEMP. 17° F.
DIFFERENTIAL PRESSURE TO FORCE GAS THROUGH 178.4 MILES 12" PIPE
INTAKE PRESSURE AT INEZ
DISCHARGE PRESSURE AT LOUISVILLE
5431 M CU. FT. DELIVERED IN 24 HOURS MEAN ATMOS. TEMP. 42°F.
PRESSURES IN LBS. PER SQ. IN.
NOON
JAN. 15, 1918
NOON
FEB. 15, 1918

FIG. 10.—TYPICAL NATURAL GAS TRANSMISSION LINE PRESSURE CONDITIONS.

PRINCIPLES OF NATURAL GAS TRANSMISSION.

TRANSMISSION IS MORE THAN MERE TRANSPORTATION.

Continuity of service from the gas sand—usually one-half mile or more below the earth's surface—through the gas main as a continuous conduit connecting the gas sand and the consumer's fixtures, many miles away, is a cardinal feature of the delivery of natural gas. The general custom of the natural gas business has been to refer to the taking of natural gas from the gas sand to the consumer as transportation. However, the word transmission more correctly expresses the actual operation.

Transmission from the roots, *trans*=across, and *mitto*=to send, emphasizes the fundamental ideas of "to send through" and "to send" and where interstate lines are involved, to "send across" such lines. The fundamental idea "to send" is especially relevant, because the gas is always sent through the line by virtue of its own expansive force, as explained on page 101, and never pulled through by anything ahead, while transportation from the roots, *trans*= across, and *porto*=to carry, suggests fundamentally transference only. That is, you transmit through, but transport over. Transmit, for "to send," fixes the attention immediately on the intervening agency and relates to the service, while transport relates to the commodity, although both imply delivery.

WHY NATURAL GAS IS COMPRESSED.

Natural gas is compressed merely to expedite transmission—for the same reason that makes it necessary to compress cotton, hay, or straw, for shipment. The first feature is to contract the volume, and secondly, to secure enough pressure range between the intake and discharge of the transmission line to secure a large enough pressure drop to force the gas through the line.

The broad public interest in an effective and continuous service and a future generation's equity in a conserved future supply makes it the duty of the gas-producing company:

1. To conserve the supply of gas in every way possible. By conservation is meant not merely saving, but using in the most effective manner. This means that it is the duty of the gas company—when it can be done without financial loss—to remove every foot of gas from the ground that can be obtained.

2. Every appliance known to the art ought to be used to bring about the most economical mining of the gas, and most effective method of transmission and distribution. A normal characteristic of every gas field is that its rock pressure declines each year as the gas is removed from the ground, as shown in graphical form in figures 3 and 4. This means that as the fields grow older it is necessary for the gas company to increase the rapidly declining pressure by mechanical means.

HOW NATURAL GAS IS COMPRESSED.

This is accomplished by a compressor which is merely a mechanical device to squeeze the gas together into a small volume, thereby increasing its pressure. The specific effect of gas compression is evident from the following: If we take 1,000 cubic feet of gas at 4 ounces gage pressure and increase the gage pressure to 300 pounds, the volume will be contracted to 46 cubic feet.

STATUS OF GAS COMPRESSOR ART.

The art of natural gas compression is now over 29 years old and has grown at practically the same rate as the increase in domestic natural gas consumers. There are now over 220 natural gas compressor stations in North America, aggregating approximately 350,000 horse power of compressor capacity and compressing about 90 per cent of all the natural gas used. The age and magnitude of the art make it evident that the use of gas compressors is a recognized integral part and universal custom of the natural gas business.

"GAS COMPRESSING" AND "GAS PUMPING."

These terms, unfortunately, are almost universally used synonymously to describe the contraction of volume of gas by compressing it with a machine known as a gas compressor.

Much misunderstanding has arisen because the term pumping station has come into general use in speaking of gas compressor stations. This is wrong, for the reason that the term pumping signifies the action of lifting alone, or lifting combined with force. In the case of natural gas transmission the work is one of pure compression, since the gas is delivered to the gas compressors under an initial pressure considerably higher than the atmospheric pressure, on account of the natural rock pressure forcing the gas out from the wells into and through the intake lines to the compressors.

ROCK PRESSURE DECLINE LOWERS COMPRESSOR CAPACITY.

As the rock pressures of the gas wells decline, the pressures that have been maintained on the intake side of the gas compressors are also lowered. This has the immediate effect of lowering the capacity of the compressing station.

The output of a typical compressor operating against a discharge pressure of 300 pounds gage is as follows, for the respective intake pressures:

Intake pressure above atmosphere.	Capacity in million cubic feet free gas each 24 hours, based on 14.4 pounds atmospheric pressure.
150 pounds	30
100 pounds	20
75 pounds	15
50 pounds	10
30 pounds	6
20 pounds	4

SIZE AND COST OF LINES NECESSARY WITHOUT COMPRESSORS.

From an engineering viewpoint it would be possible to take the gas to market without compressors, by simply building a great number of large size lines. However, the number and cost of lines neces-

sary to do this would be so great as to make the plan prohibitive from a financial viewpoint. That is, the gas compression method is the economical way of handling the problem. The natural gas compressor performs a similar function to the step-up transformer for an electrical transmission line.

NO HEAT LOSS IN NATURAL GAS COMPRESSION.

Contrary to a widespread popular opinion, the compression of natural gas does not decrease its heating value. While a certain amount of gas is used to drive the compressors, this does not in any way affect the heating value of the gas passing through the compressors. On account of the mechanical work performed on the gas as it flows through the compressors the gas becomes quite warm, and to protect the rubbers in the main lines, is cooled just beyond the compressor discharge before it goes into the main line transmission system. This, however, pertains merely to the temperature of the gas itself, and in no way affects its heating value.

NOT FEASIBLE TO MAKE NATURAL GAS MAIN LINES COMMON CARRIERS.

The natural gas main lines form the connecting link between the mining operations in the natural gas field and the public utility service in the city distributing plants. A number of attempts have been made by large consumers, owning natural gas in the field, to have the main transmission lines made common carriers so that they could be compelled to haul the large consumer's gas to market. The converting of main lines into common carriers is not only not feasible from an operating viewpoint, but the idea could be based only on distinctly local and selfish interests, and would ignore entirely the domestic consumers' interest. That is, this plan would greatly injure service to the over 2,000,000 domestic natural gas consumers in the United States, because it is not generally appreciated that:

1. There is a clear distinction between the duties of a common carrier or railroad, and the duties of a public utility.

(*a*) The terms "railroad," "common carrier," and "public utility" are frequently confused. A railroad is a common carrier that undertakes for hire to transport persons or goods, or both, from place to place, for all persons indifferently. The fundamental duty of a railroad or common carrier being indifference as to who shall be served, and an equal readiness to serve all who apply in the order of their application. On the other hand a property becomes a public utility only when dedicated to a public use.

(*b*) Even though legislative enactments would be passed declaring natural gas lines public transportation agencies—that is, common carriers—they could not be enforced because such legislation would be in direct conflict with well-known economic and engineering

facts. The entire natural gas transportation problem is controlled by economic and engineering laws. These laws can neither be abrogated nor altered by company policy, contractual relations, public opinion, legislative enactment, or judicial decree. They are entirely independent of human opinion, and as certain in their operations as the law of gravitation. Therefore, no mere statement of any governing body can make a public transportation agency of a natural gas line.

(*c*) The fundamental requirement of a common carrier agency like a railroad is nondiscrimination, and this can in no way be applied to the duties of a natural gas company. A natural gas company operating a natural gas transmission line and supplying domestic consumers, from the very nature of things, gives its own consumers preference on account of public policy and the contractual relations existing between such consumers and the gas company.

2. The consumers' interests and rights extend clear back to and depend on the gas wells and reserve acreage the producing company maintains to insure an adequate present and continuous future service. Common carrier obligations for the transmission line would:

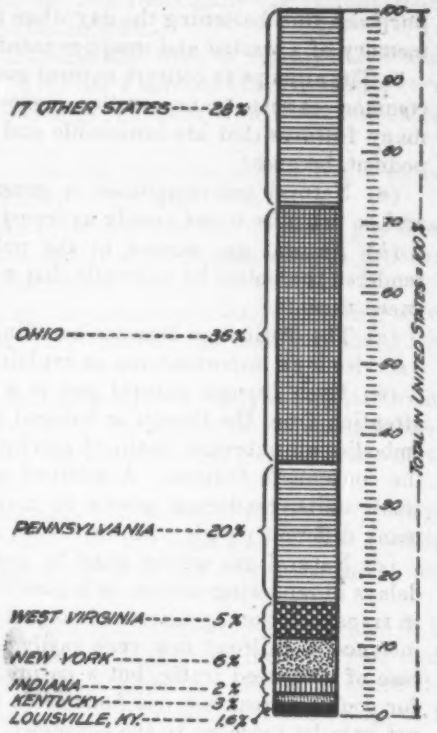

FIG. 17.—GEOGRAPHICAL DISTRIBUTION OF DOMESTIC NATURAL GAS CONSUMERS BY STATES.

(*a*) Tend to soon exhaust the available supply and leave the householders with large investments of appliances and pipes which will be useless, owing to the permanent failure of gas.

(*b*) So disorganize the existing business as to make it impossible to render satisfactory continuous service to either domestic or industrial consumers. This would be true regardless of what might be charged.

(*c*) Make the consumers—especially the domestic—subordinate to occasional producers; that is, to men who have no intention of following the business of hunting for gas for future service, but would be interested only in finding a good market, at the expense of others, for such gas as might be found as a result of an occasional accidental venture.

(*d*) In all cases, where tried, impair and usually destroy the cooking, heating, and lighting service of the domestic consumer.

(*e*) Greatly increase the amount of gas used for manufacturing purposes, thus hastening the day when natural gas will be merely the memory of a wasted and unappreciated resource.

3. The attempt to convert natural gas transmission lines into mere common carrier transportation agencies, like railroads, presents many features that are impossible and none that are feasible or expedient, because:

(*a*) Natural gas companies in general are not chartered to act, and do not offer to act merely as transportation agencies.

(*b*) Natural gas service to the public is so unlike the service rendered the public by railroads that no comparison can be made between them.

(*c*) The distinction between handling a commodity and rendering a service is an important one, as explained on page 34.

(*d*) Even though natural gas is a mineral it requires constant attention from the time it is reduced to possession at the well, and embodies an unbroken chain of service features until it is burned at the consumer's fixtures. A railroad may operate its line in many small units, rendering service to many different localities and to many different people with unrelated, isolated service units.

(*e*) Natural gas service must be instantaneous. There can be no delays in rendering service, as is possible (and universally practiced) in transportation agencies such as railroads and traction lines. For instance, a railroad can very easily start service one hour late in case of congested traffic, but a natural gas service that delivers gas for cooking breakfast one hour after the consumer needed it would not only be valueless to the consumer, but would not be tolerated in any community. This instantaneous feature differentiates natural gas service from all transportation agencies.

(*f*) The gas is never at rest, but is a constantly seething, moving mass between the gas in the field and the consumers' fixtures in the cities. The gas travels at enormous velocities in the mains at a speed many times exceeding that of the fastest trains.

(*g*) The gas can go in only one direction.

(*h*) Storage facilities are not feasible for the gas either in the field or in transit.

(*i*) The gas pressures must be varied to suit the operating conditions of the line; that is, at the intake of the line the pressure must be large and at the discharge end of the line the pressure must be relatively low as shown on page 27.

(*j*) There is no delivery until the gas has not only passed through the consumer's meter, but is burned at the consumer's fixtures.

(*k*) In considering the gas that goes through the line there can be no "identity of property," no "segregation of ownership," and no "original package containers," but all of the gas obtained from various sources passes through the line thoroughly intermixed with absolutely no possibility for identification.

(*l*) The capacity of the transmission lines is rigidly fixed and will not stand any overload. This has a marked effect in taking care of peak loads, in contradistinction to railroads, which may run extra trains to carry extra traffic.

(*m*) A natural gas line can handle only one commodity, whereas railroads can handle every known commodity.

(*n*) Railroads have vehicles of transportation. Natural gas lines have none. The pipe line is merely a continuous conduit between the field and the consumer's fixtures.

(*o*) A natural gas line can not have extensive interconnecting service with other lines, whereas every railroad can handle commodities from every other railroad.

(*p*) The transmission of natural gas is naturally centralized relatively near the fields of production, the deliveries being made near the fields, and not throughout the whole United States, as are commodities handled by railroads.

(*q*) The domestic gas consumers will not contract for, or agree to use, a fixed amount of gas each day, but take gas as they need it, in all cases insisting and requiring that the service be made and maintained continuous.

(*r*) The company can not create the commodity upon which it is performing its service as is possible with manufactured gas, electricity, or any of the transportation agencies; neither is there the constant replacement by nature of the commodity it is serving, as is the case in waterworks plants.

(*s*) The system must be operated as one unit, without regard to state lines.

4. Gas companies discharging their legal duty to their domestic consumers can not depend upon the initiative of the occasional producer for a supply of gas, but must depend upon their own initiative in order to maintain proper field operating conditions and an adequate reserve acreage for future development to insure a good serv-

ice to their patrons. In West Virginia the total production is delivered as follows:

	Per cent.
Utilities	82
Small producers, with no public utility duties	13
Carbon black manufacturers	5
	100

Experience has many times shown that satisfactory continuous service to the consumer can be rendered only when the production, transmission, and distributing features are properly coordinated. To subordinate the transmission side of the business to either the producer's or the larger industrial consumer's interest is indefensible.

NATURAL GAS DISTRIBUTION.

NATURAL GAS IS A SERVICE, NOT A COMMODITY.

The furnishing of a service, rather than the delivering of a commodity or product, is the dominating feature of the natural gas business. To consider the gas merely as a commodity is fundamentally wrong. When a natural gas utility prospects for, finds, and reduces the fugitive, wandering and uncontrolled natural gas to possession, and then converts this crude natural gas—made up of a mechanical mixture of permanent gases and condensible vapors—into a controlled and usable service delivered to the consumer's fixtures, usually many miles from the gas field, the service features pertaining to the method and manner of delivery, and standing ready to serve are of much more importance than the product or commodity.

The difference between rendering a service and marketing a commodity is an important one. The commodity may be manufactured at a uniform rate of production and then placed in storage until it can be sold to advantage, while a service must be used at the moment it is offered or it will become forever useless. The load factor data on page 35 emphasized, first, the erratic nature of natural gas loads and, secondly, the potential opportunities for rendering service that can never be used.

WHY GAS CONSUMERS USE MORE NATURAL GAS THAN MANUFACTURED GAS.

The average consumption in M cubic feet of natural gas for all the domestic natural gas consumers in the United States is 100 M cubic feet by each domestic consumer annually. The consumption data for Charleston, Huntington, and Louisville, Kentucky, is shown in graphical form on pages 35 and 36.

The average of 682 manufactured gas companies, as reported in Brown's Gas Directory, was 22 M cubic feet of manufactured gas to each domestic consumer a year. The actual average annual con-

sumption of manufactured gas at Louisville, Kentucky, prior to the introduction of natural gas was 24 M cubic feet.

The reasons for this large increase in domestic natural gas consumption are as follows:

1. Natural gas prices have been so low as not to make the gas worth saving.

2. The efficiencies of most natural gas using appliances are generally less than for manufactured gas using appliances. See page 40.

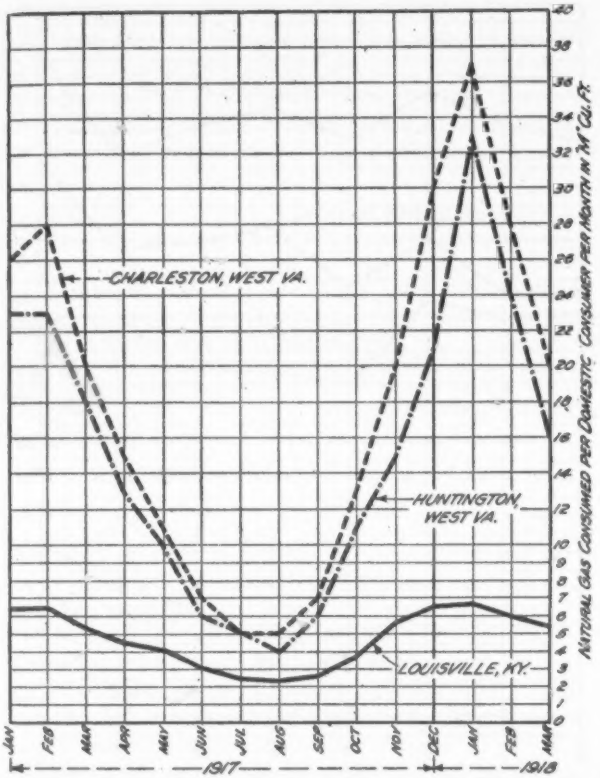

FIG. 12.—MONTHLY AVERAGE NATURAL GAS CONSUMPTION PER DOMESTIC CONSUMER.

3. Manufactured gas is used primarily for cooking, hot water heating, and lighting only. The largest part of the natural gas business results from its extensive use for house-heating services, where the volume required is very much greater.

PEAK LOAD SERVICE.

Abnormal peaks of very short duration are characteristic of all natural gas loads for domestic consumers. This necessitates a large

property value for equipment that is actually used only a very short period out of each year. Every natural gas company must have considerable equipment that will be used not over four hours daily during say 30 of the coldest days of a year of normal temperature. The smallness of this is evident from the following:

Total number hours in the year..... $24 \times 365 = 8,760 = 100$ per cent.
Hours peak load equipment is actually used ..... $4 \times 30 = 120 = 1.4$ per cent.

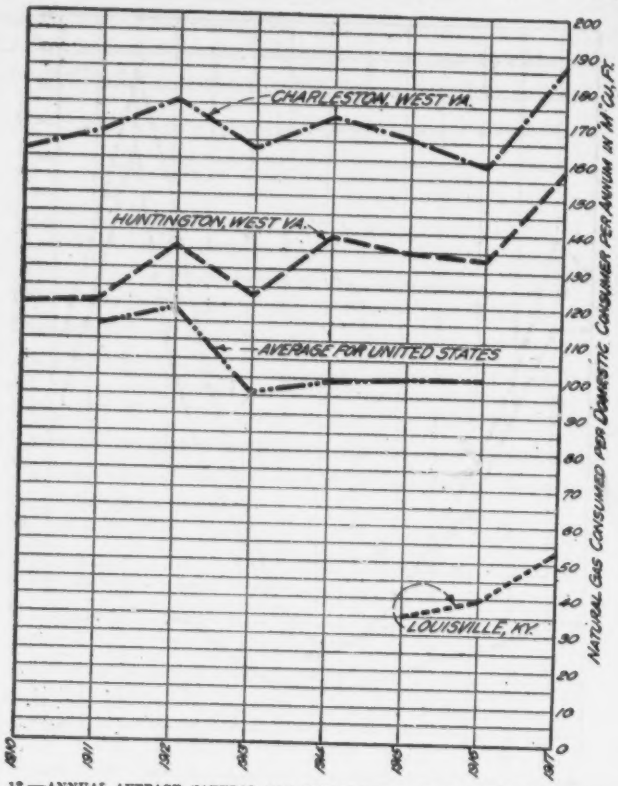

FIG. 13.—ANNUAL AVERAGE NATURAL GAS CONSUMPTION PER DOMESTIC CONSUMER.

Industrial loads ordinarily are very much more uniform than domestic loads. This is especially true of the carbon black industry in the field, where the load can be made uniform every day of the year. The relationship between maximum, minimum, and average load conditions is shown on page 37.

PEAK LOADS INCREASE COST OF SERVICE.

An increase of volume of business can decrease the cost of production only when the increment of increase is distributed so as to make

possible the more efficient use of existing equipment. When the increment of increase is concentrated so as to require more equipment, as is the case in all peak loads, the cost of production to the unit of service is increased. Therefore, the cost of peak load natural gas service is greater than the cost of normal service. A rate schedule, to be equitable to all consumers of natural gas, must make the consumers who need and create the peak load service, pay a price that will be commensurate with the extra cost of the service they are receiving.

House heating furnace services not only produce marked peaks each day, but the consumption is limited to relatively a short period out of each year. For this reason house heating furnace service costs more than ordinary gas service. This emphasizes the desirability of the use of auxiliary heating equipment, as outlined on page 38.

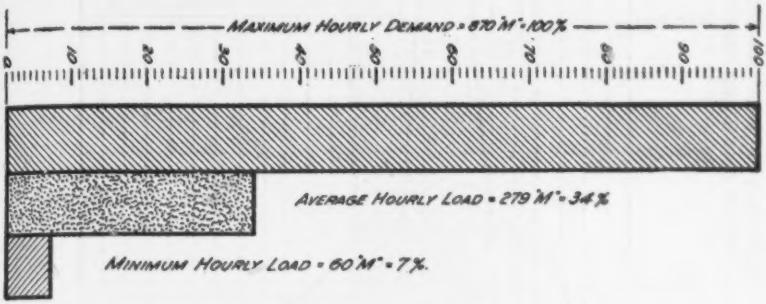

FIG. 14.—RELATION OF MAXIMUM, AVERAGE, AND MINIMUM HOURLY NATURAL GAS LOADS.

BASIC REASONS FOR LARGE SALES OF INDUSTRIAL GAS.

These have been inadequate domestic price and policy of Government in fostering competition in the gas field.

During the domestic off-peak period—usually nine months of the year—about 60 per cent of the equipment of a gas company is not needed for domestic natural gas service. Under competitive conditions in the field the gas can not be conserved for future use, except by unity of action of all producing companies. As the Government has always fostered competition, and therefore waste, the inevitable result has been to stimulate low-priced industrial gas sales, because:

1. The companies needed the revenue to make up the deficit from their too low priced domestic gas service.

2. As no one company could save its gas, except by the prohibitive "unity of action of all producers," each took all the gas it could get, as fast as it could get it out, thereby greatly depleting the supply for future service.

At the present time of all the gas produced in the United States, practically two-thirds is used in industrial service. The percentage of total State consumption that is used for industrial service, for several States, is shown on page 39.

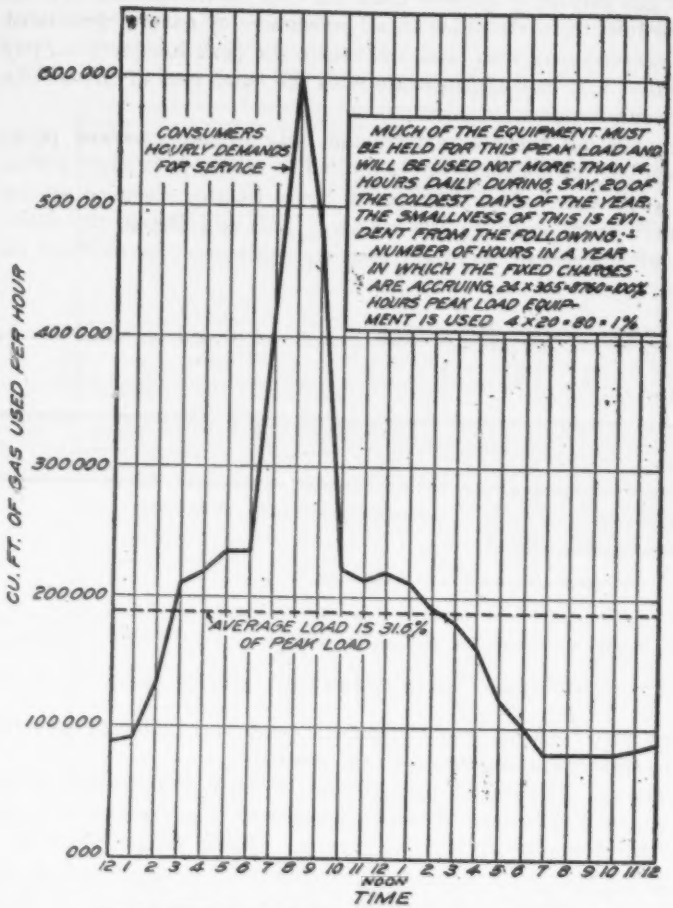
600 000
500 000
400 000
300 000
200 000
100 000
000
CU. FT. OF GAS USED PER HOUR
CONSUMERS HOURLY DEMANDS FOR SERVICE →
MUCH OF THE EQUIPMENT MUST BE HELD FOR THIS PEAK LOAD AND WILL BE USED NOT MORE THAN 4 HOURS DAILY DURING, SAY, 20 OF THE COLDEST DAYS OF THE YEAR. THE SMALLNESS OF THIS IS EVIDENT FROM THE FOLLOWING:
NUMBER OF HOURS IN A YEAR IN WHICH THE FIXED CHARGES ARE ACCRUING, 24 × 365 = 8760 = 100%
HOURS PEAK LOAD EQUIPMENT IS USED 4 × 20 = 80 = 1%
AVERAGE LOAD IS 31.6% OF PEAK LOAD
12 1 2 3 4 5 6 7 8 9 10 11 12 / 1 2 3 4 5 6 7 8 9 10 11 12
NOON
TIME

FIG. 15.—TYPICAL HOURLY NATURAL GAS LOAD IN WINTER.

The pooling operating conditions referred to on pages 62 and 63 would greatly curtail this misuse of gas for industrial purposes.

PEAK LOAD CONDITIONS ANALOGOUS TO STRAP HANGER PROBLEM.

While it would be possible for a street car company to install and operate enough cars during the peak-load period to give everyone

a seat, yet the cost of so doing would make the general service cost much more than the additional advantages would be worth. Since the demand for seats may be four or five times as great during the rush hours as it is in the middle of the day, the only feasible way to deal with this situation is to admit the necessity of a different standard of service for rush and nonrush periods. Since the fare remains constant, it becomes necessary to provide relatively fewer cars, and therefore fewer available seats, for the rush period than for the nonrush travel.

But for the uniformity of street railway rates, the rush hour passenger might justifiably be charged more than the nonrush passenger. Conversely, it is not unreasonable that he should, paying the same fare, expect to have to put up with a somewhat less comfortable ride at that time. There is certainly little economic ground for an especially reduced fare for this service.[1]

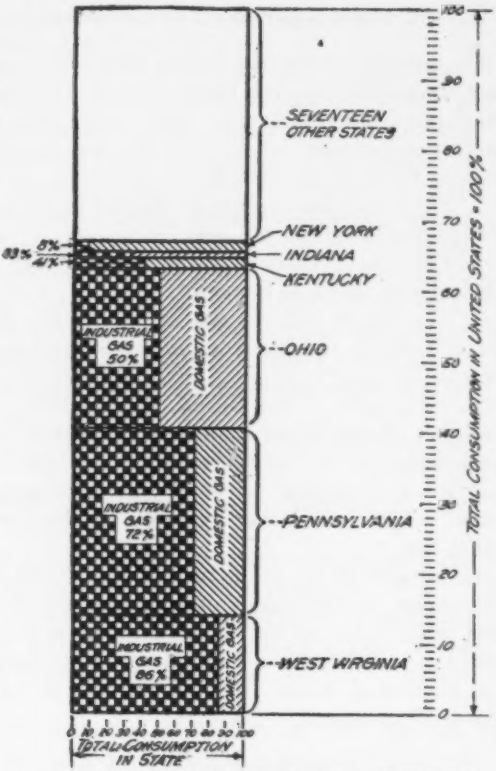

FIG. 16.—RELATION OF INDUSTRIAL AND DOMESTIC NATURAL GAS CONSUMPTION.

This is precisely the situation with regard to natural gas pressures during the peak load period, with this further feature, that the natural gas peak load periods cover relatively only a few days of the year, as against the everyday situation on street car traffic. As long as natural gas prices for the higher costing peak load service remain the same, the consumer must therefore expect a lower standard of service during that period.

[1] Quarterly Journal of Economics, August, 1911, p. 623.

USE OF AUXILIARY HEATING APPLIANCES.

It is desirable in all cases where possible to have auxiliary heating equipment available for supplementing or entirely replacing for a short period natural gas for house-heating service, during the peak period of the load. Where gas furnaces are used, auxiliary oil burners can be installed in such fire pots, or auxiliary coal furnaces can be installed alongside the gas furnaces, where the coal furnace would discharge its heated air into the gas furnace shell.

FEW IMPROVEMENTS IN ART OF USING NATURAL GAS.

On account of the low prices that have prevailed, gas-appliance manufacturers have not been stimulated to the development of efficient gas-using equipment. There have been few improvements resulting in increased efficiency in the last 15 years. In testing house-heating furnaces it has been found that:

1. The use of natural gas in the fire pot of a coal furnace gives an efficiency of about 25 per cent.

2. The use of natural gas in the ordinary gas furnace gives an efficiency of about 35 per cent.

3. The use of natural gas in a correctly designed and built gas furnace, where the construction conditions permit the fullest utilization of the heat in the gas, gives an efficiency of about 75 per cent.

In tests made by the Bureau of Standards, it was found that the ordinary incandescent mantle lamp where used with natural gas wasted nearly half of the possible heat that could be used if such lamps were designed for as efficient operation on the high heating value natural gas as they give on the low heating value manufactured gas.

In tests made by the department of home economics, Ohio State University, the efficiencies of a natural gas range varied from 37 per cent with 0.2 of an ounce pressure down to 13 per cent at 4-ounce pressure,[1] while with a manufactured gas range, using natural gas, the efficiencies varied from 43 per cent at 0.2 ounce pressure to 23 per cent at one-ounce pressure.

COOKING AND HEATING DISTINGUISHED.

In a heating operation it is merely necessary to secure perfect combustion in the heating device, because in so doing all of the available heat in the gas can be utilized. In cooking it is not only desirable to secure a perfect combustion, but absolutely necessary to direct the heat to a particular place, in a particular manner, and sometimes at a particular time. It is for this reason that gas-cooking operations are

[1] Ohio State University Bulletin, vol. 22, No. 28, May, 1918: Effect of Gas Pressure on Natural Gas Cooking Operations in the Home.

more susceptible to changed pressure conditions than heating operations.

It may not be amiss to emphasize that the time element in many cooking operations is of much more importance than intensity.

WHAT IS USABLE NATURAL GAS PRESSURE.

The pressures carried by most natural gas companies have been too high for efficient service. This has had the further undesirable feature of teaching the consumer to believe that he was not receiving service unless the gas could be heard hissing through the orifice in the gas mixer. It has been demonstrated that [1]—

1. Satisfactory cooking operations in frying potatoes, boiling potatoes, frying beefsteak, and pan-broiling beefsteak can be carried on with 0.2 ounce natural gas pressure. This merely requires that the short flame and cooking vessel be brought together. The changes in vessel position necessary to permit satisfactory operation at pressures as low as 0.2 ounce are easy to make, require no special changes in existing stoves, and consist merely, with drilled burners, in placing three nails in three of the drilled holes, and, with slotted burners, of placing three small pieces of tin in three of the slots, in order to support the cooking vessel at the proper distance from the burner, and close enough so that the short flame can do effective work.

2. Better results are obtained with pressures in the neighborhood of 2 ounces than at 4 ounces.

3. Less gas is used at pressures in the neighborhood of 2 ounces than at 4 or 5 ounces.

4. Manufactured gas range gives better results than natural gas range because the former is designed for low pressures.

5. There is very little difference in the time required to carry on cooking operations with pressures of from 1 to 5 ounces.

Therefore, if the consumer will use proper appliances, satisfactory cooking operations can be carried on with pressures as low as 0.2 ounce and the gas passing through the meter will perform a usable service.

With heating appliances, if the mixer is properly adjusted the combustion at low pressures can be made substantially as thorough as at high pressures, and the consumer can have the benefit of all the heat generated by the burning gas, although if the pressure is low he will invariably not have nearly as much as he would like to have or as he needs. However, all of the gas measured by the meter and burned in the heating appliance is used for a useful service, so far as it goes, although under extreme low pressure conditions there is not enough to give all consumers all they want.

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[1] Ohio State University Bulletin, vol. 22, No. 28, May, 1918: Effect of Gas Pressure on Natural Gas Cooking Operations in the Home.

ACCURACY OF METER REGISTRATION AT LOW AND VARIOUS GAS PRESSURES.

The popular belief is that meters run faster when the pressure is low than when the pressure is high. This is contrary to the facts. Variation in pressure makes no appreciable difference in the registration of the meter, the meter merely registering, within a reasonable limit of tolerance, the amount of gas that passes, and this is neither increased nor decreased by changes in pressure.[1]

EFFECT OF GAS PRESSURE ON GAS LEAKAGE.

A summary of gas leakage laws is given on page 58. From these it will be seen that the leakage at 4-ounce pressure is twice as great as at 1-ounce. For this reason the leakage in the city distributing plant and on the consumer's premises, which is paid for by the consumer because the gas must pass through the consumer's meter in order to leak away on his premises, will be substantially less if the distributing plant and consumer's fixtures are adjusted for low pressures rather than high pressures.

GAS METER FACTS.

The following features regarding gas meters should be borne in mind:

1. Gas meters have no power within themselves to register. The only way they can be made to register is by the passage of gas through the meter. The gas company has absolutely nothing to do with the operation, nor can it in any way control the registration of the meter. However, many times gas meters register when gas is not being used, due to leakage in house fixtures.

2. The gas consumption will not be increased by the use of a large meter.

3. The gas consumption will not be decreased by the use of a small meter. In fact, if the meter is too small the gas service will be unsatisfactory.

4. Gas bills are not made out regardless of gas consumption. While it is possible for the meter reader to make an error for one month, this will be automatically rectified in the reading of the following month.

5. High gas pressure does not increase or decrease the rate of registration of meter.

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[1] The same conclusion was reached in: Engineering Bulletin No. 2 of the University of Kansas, on Natural Gas: Its Properties, Its Domestic Use, and Its Measurement by Meters, under date of July 1, 1912. Paper on Value of Gas Delivered at Varying Pressures, by Charles V. Critchfield, of the Ohio Public Utilities Commission, read at the Pittsburgh meeting of the Natural Gas Association of America, May, 1918. Ohio State University Bulletin, vol. 22, No. 28, May, 1918: Effect of Gas Pressure on Natural Gas Cooking Operations in the Home.

6. Low gas pressure does not increase or decrease the rate of registration of the gas meter.

7. It is impossible for a gas meter to register twice. When the gas has passed through the meter it can not pass through the second time.

8. Meters do not always register fast. There are just as many times when they register slow, and this is to the detriment of the gas company.

DISTINCTION BETWEEN LUXURY AND NECESSITY IN NATURAL GAS SERVICE.

To the average family for cooking, hot water boiler heating, lighting, and incidental house heating service, natural gas is a necessity, but when used in larger quantities or for house-heating furnace work it becomes a luxury. Furthermore, the peak load characteristics of house heating furnace service make this service cost more to the natural gas company. An equitable schedule of rates ought, therefore, to provide for a fixed net price per thousand cubic feet for a large enough monthly consumption to permit of the cooking, hot water boiler heating, lighting, and incidental house heating service necessary in the average family. If this fixed consumption is exceeded, then the price of a thousand cubic feet for such excess consumption ought to be increased so as to make the consumer pay for the higher priced service he is receiving.

It is a trite observation that the luxuries of one day tend to become the necessities of the next. Most complaints for inadequate service during the few peak load hours, usually less than 1 per cent of the total 8,760 hours in the year,[1] are based on the fallacy that a service that is purely a privilege has become a prerogative; that is, natural gas consumers as compared with other fuel users who have to use solid fuel or manufactured gas are a privileged class enjoying a luxury that is seldom appreciated until it becomes difficult to obtain, and on account of the limitations fixed by nature they do not possess and can not ask any inalienable rights of service, under conditions that are physically impossible to meet.

CONSUMER IS RESPONSIBLE FOR ECONOMIC USE OF GAS.

The consumer's use of gas has an important bearing on the efficiency of results that may be obtained, as discussed on page 40. Few people appreciate that even in an ordinary frying operation effective results can not be obtained unless the vessel position is close enough to the flame so that the tip of the flame can deliver the heat generated in an effective manner. Even with high pressure and long flames, if a strong draft should deflect the flame the cooking service will be unsatisfactory.

[1] Few people appreciate that even if the service averages below normal 5 hours a day for 17 days, the total period of normal service is still more than 99 per cent.

When mantle burners are opened so as to admit more gas than is necessary, the familiar "hissing" or blowing sound is produced. This has, first, a tendency to break the mantle and chimney; second, waste the gas; and, third, lowers the candlepower of the lamp. The majority of natural gas consumers do not appreciate that gas burners need care and attention and that periodic cleaning is absolutely essential if satisfactory results are to be obtained.

The data given on page 40 show the marked differences in results that may be obtained in using natural gas in the fire pot of an ordinary coal furnace, as against a specially built natural gas furnace.

BAROMETRIC CHANGES MAKE MORE DIFFERENCE ON TOTAL PRESSURE THAN GAGE PRESSURE VARIATION.

On account of the changing atmospheric conditions, the barometric pressure varies from day to day and from hour to hour on the same day. Thus, the atmospheric pressure at Louisville, Ky., on January 21, 1918, was 30.47, and on January 11 was 29.19 inches, this difference of 1.28 inches of mercury being the equivalent of 0.627 pound to the square inch, or 10 ounces to the square inch, or considerably more than the entire range of variation in gage pressure.

ATMOSPHERIC TEMPERATURE CHANGES HEATING VALUE OF GAS MORE THAN CHANGES IN GAGE PRESSURE.

The variation in mean monthly temperature of natural gas at Louisville, Ky., is shown on page 45.

The variation in temperature of natural gas in the underground mains makes more difference in the heating value than the variation in gage pressure. The maximum fluctuation in temperature produces a difference in heating value of about 5 per cent, while the maximum fluctuation in pressure produces a difference in heating value of less than 4 per cent. Furthermore, these variations work in opposite directions; that is, in winter time when the pressure is low, therefore tending to decrease the heating value, the temperature is low, tending to increase the heating value. This increase due to low temperature will always be more than the decrease due to low pressure.

EFFECT OF PRESSURE OR TEMPERATURE CHANGES ON HEATING VALUE OF GAS.

These will produce changes in volume, but will neither destroy nor create any heat units, and hence will neither increase nor decrease the total number of heat units contained in the gas. However, the volumetric changes will always alter the distribution of the total number of heat units, as follows:

Gage pressure above atmosphere.	Relative British thermal unit.	Relative per cent.	Gage pressure above atmosphere.	Relative British thermal unit.	Relative per cent.
Ounces.			*Ounces.*		
8	1,034	103.4	3	1,013	101.3
7	1,030	103	2	1,009	100.9
6	1,026	102.6	1	1,005	100.5
5	1,022	102.2	0	1,000	100
4	1,017	101.7			

Gas temperature.	Relative British thermal unit.	Relative per cent.	Gas temperature.	Relative British thermal unit.	Relative per cent.
° *F.*					
70	960	96	50	1,000	100
65	970	97	45	1,010	101
60	980	98	40	1,020	102
55	990	99	35	1,030	103

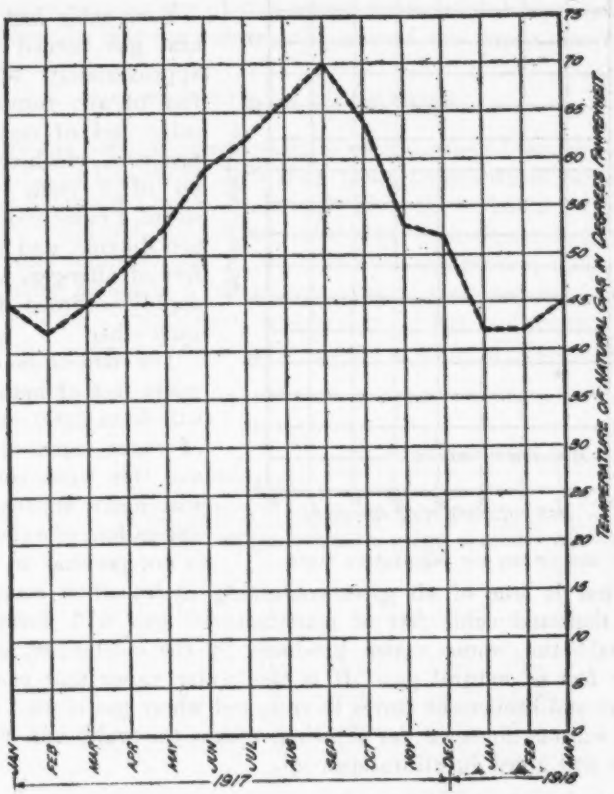

FIG. 17.—MEAN MONTHLY TEMPERATURES OF NATURAL GAS IN GAS MAINS.

COMBUSTION OF NATURAL GAS.

The combustible constituents of natural gas are made up of combinations of the elements carbon and hydrogen. When natural gas is burned so as to secure perfect combustion, only carbon dioxide and water vapor are formed. That is, the carbon of the gas unites with the oxygen of the air forming carbon dioxide, and the hydrogen of the gas unites with the oxygen of the air forming water vapor. The water vapor, of course, will condense when cooled. This water vapor does not come from the gas, but is created and formed by the chemical action of the hydrogen in the gas and the oxygen in the air.

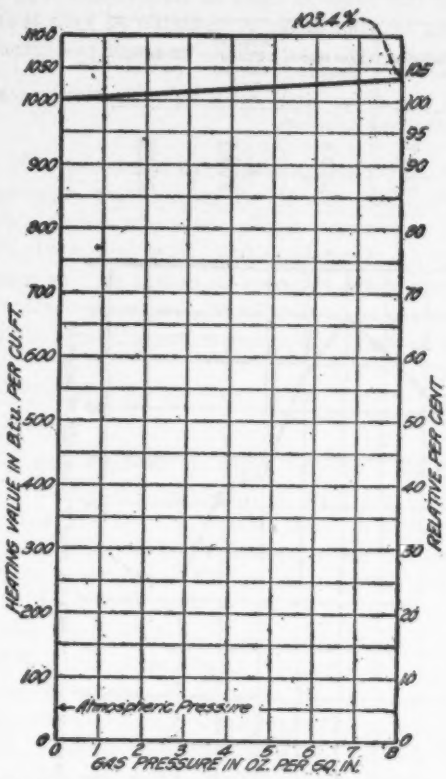

FIG. 18.—CURVE SHOWING EFFECT OF GAS PRESSURE ON GAS VOLUME AND GAS HEATING VALUE.

Each cubic foot of natural gas burned requires approximately 9½ cubic feet of air, forming 10½ cubic feet of combustion products, which are made up of 2 cubic feet of steam, 1 cubic foot of carbon dioxide, and 7½ cubic feet of nitrogen, all thoroughly diffused through each other.

The combustion of 1,000 cubic feet of natural gas will form 2,000 cubic feet of water vapor or steam, and this when condensed will make approximately 10½ gallons of water. This is not peculiar to natural gas, but is true of all gases containing hydrocarbon compounds. One thousand cubic feet of manufactured gas will form about one-half the water vapor produced by the combustion of 1,000 cubic feet of natural gas. It is this water vapor that causes the bakers and broilers of stoves to rust, and where gas is used in open fires without flues, or for lighting, makes the walls and windows sweat and glued furniture open up.

If the combustion is not perfect, then carbon monoxide, which is a deadly poison, may be formed. The toxic action of this is so marked that one-tenth of 1 per cent is enough to produce fatal results. This is especially likely to be formed when a flame is suddenly impinged on a cold surface, as, for instance, the first few seconds' operation of an instantaneous hot water heater.

EFFECT OF ATMOSPHERIC TEMPERATURE ON DEMANDS FOR GAS.

The temperature of the atmosphere has a direct bearing on the demands for natural gas for heating service. However, the quantity of cooking, incidental hot water heating, and lighting is independent of the temperature of the atmosphere and would be practically constant for the year. The humidity of the atmosphere, direction and velocity of wind, and hours of sunshine, also affect gas consumption, as far as heating service is concerned. In general a high wind causes more of an increase than merely a low temperature. The mean monthly temperature curve plotted upside down will always show a close relationship between volume of gas used and temperature of atmosphere.

DAILY DEMANDS FOR GAS HEATING SERVICE.

The daily gas heating consumption to each degree of temperature below 70° F., at Louisville, Ky., from mean temperatures ranging from 2° on February 2 to 58° on January 29, is shown below.

It will be noted that the heating service for each degree is larger at the warmer temperatures. This is because the general tendency is to keep most houses at a higher temperature than necessary, and for this reason on account of the cheapness of the gas, and the general absence of thermostat control devices, the gas is not used as efficiently.

Daily gas heating consumption for each degree of temperature below 70° F.

Date.	Mean temperature of atmosphere, degrees F.	Difference between mean temperature and 70°, 70–A.	M cubic feet natural gas a day.			
			Delivered to Louisville.	Service independent of atmospheric temperature.	Heating service.	Heating service per degree below 70° F. (E÷B).
	(A)	(B)	(C)	(D)	(E)	(F)
1917.						
Feb. 2	2	68	13,209	4,500	8,709	128
Jan. 14	10	60	12,193	4,500	7,693	128
Jan. 11	20	50	11,370	4,500	6,870	137
Jan. 26	30	40	10,869	4,500	6,369	159
Jan. 6	39	31	9,142	4,500	4,642	149
Jan. 3	48	22	7,852	4,500	3,352	152
Jan. 29	58	12	6,830	4,500	2,330	194
Average						150

MONTHLY DEMANDS FOR GAS HEATING SERVICE.

When the atmospheric temperature drops below 70° F. demands for heating service are created which are practically proportional to the number of degrees that the atmospheric temperature is below 70. The variation in monthly demands for each degree of atmospheric temperature below 70° F. is shown in the following table.

The data in column D is the estimated gas consumption for cooking, incidental hot water heating, and lighting, which is entirely independent of the atmospheric temperature, and the estimated figure is taken approximately as the total amounts delivered during the months of June, July, August, and September, when there are practically no demands for heating service.

The average of the demands for heating service at Louisville, Ky., for each degree below 70° F., for the months of January, March, April, May, October, and November, 1917, and March 1918, when enough gas was available to meet the demands, was 5,500,000 cubic feet for each month for each degree below 70° F.

Monthly gas heating consumption for each degree below 70° F.

Date.	Mean monthly temperature of atmosphere, in degrees F. (A)	Difference between mean temperature and 70° F., 70-A. (B)	Million cubic feet natural gas a month. Delivered to Louisville. (C)	Service independent of atmospheric temperature. (D)	Heating service (C–D). (E)	Demands for heating service per degree below 70° F. (E÷B). (F)
1917.						
January	36	34	302	140	162	4.8
February	32	38	260	140	120	3.2[1]
March	46	24	260	140	120	5
April	55	15	232	140	92	6.1
May	60	10	204	140	64	6.4
June	72	.....	140	.....	.....	.....
July	76	.....	131	.....	.....	.....
August	76	.....	134	.....	.....	.....
September	69	.....	149	.....	.....	.....
October	51	19	243	140	103	5
November	45	25	270	140	130	6.2
December	26	44	269	140	129	2.9[1]
1918.						
January	20	50	263	140	123	2.4[1]
February	38	32	223	140	83	2.5[1]
March	51	19	232	140	92	4.9
Average of normal months.	.....	.....	.....	.....	.....	5.5

[1] Not enough gas available to meet demands.

WHY STANDARDS FOR NATURAL GAS SERVICE MUST BE LOWER THAN FOR MANUFACTURED GAS.

The operating conditions in a natural gas plant are so different from those prevailing in a manufactured gas plant that the standards of service that would reasonably be applicable to the latter would not be feasible or expedient with natural gas, because:

1. The volume of natural gas business for each domestic consumer is generally about five times as large as for manufactured gas.

2. The peak load difficulties in a natural gas load are much more troublesome than in manufactured gas, due primarily to the heating load, which fluctuates with the atmospheric temperature.

3. The service standards can not be limited to merely the distributing plant limits, but would be closely related to the main pipe lines, back into the field to the compressing stations, and general field operating conditions.

4. The natural gas company can not create the basic feature of the service it is selling to the public, but must depend entirely on the caprice of nature for this.

5. Every foot of gas sold represents in effect the sale of a part of the company's property.

6. Since there is no regeneration, the supply can be kept continuous only by constant and persistent hunting for new supplies.

7. Although the distributing end is a public utility service, the field or producing end is a mining proposition, and the continuous connection of the two by the transmission line has the immediate effect of also connecting the mining hazards to the distributing end of the business.

8. The migratory tendencies and fugitive nature of natural gas under the ground make its reduction to possession much more difficult than for solid minerals.

9. In general, the prices for natural gas service have not been adequate, and have not been made on the basis of rendering as uniform a condition of service, especially with regard to pressure, as can be maintained in a manufactured gas plant.

10. Both the quality and quantity are entirely controlled by nature.

DISCOUNT FOR LOWER PRESSURES STIMULATES WASTE.

A penalty clause providing for a discount when pressures less than 4 ounces are maintained has been suggested as a means of guaranteeing good service. However, instead of guaranteeing service it stimulates waste for the reasons given on page 54. The penalty clause is inequitable and fails to recognize the well known operating characteristics of the mining, transmission, and distribution of natural gas, which, therefore, differentiate this from every other type of public utility service, more particularly by:

1. Failure to recognize that the heating value of the gas does not decrease proportionally with the decrease in gage pressure.

2. Failure to recognize that neither the efficiency nor the efficacy of gas decreases proportionally with the decrease in gage pressure.

3. Failure to recognize that higher efficiencies may be obtained at pressures below 4 ounces than at 4 ounces and above.

4. By ignoring rate of flow or volume of gas to be delivered and the close relationship that exists between volumetric demands and the constantly changing and uncertain and unpredeterminable atmospheric temperature changes.

5. General conservation methods in the field have not been followed in the past; gas has been produced, transmitted, and distributed in a most wasteful manner, which has, therefore, very greatly depleted available supplies, highly desirable for peak-load service.

6. The uncertain, migratory, and fugitive nature of the gas in the underground reservoirs, where it is entirely beyond the control of the human will, legal process, or contractual relationship, and yet where its expansive properties under the ground must be taken as the initial step for the delivering of service to consumers 200 miles away, obviously makes it evident that considerable leeway must be allowed in service standards.

EXTENSION OF SERVICE.

In considering the question of the desirability of making new extensions after a natural gas supply has become depleted, so as to make satisfactory service for all impossible, two distinct viewpoints have been developed, namely:

The Indiana Supreme Court in 1901 held that:

> A natural gas company * * * can not refuse to permit connections with its mains by unsupplied citizens because the gas pressure has fallen so low that existing customers can not be adequately supplied, and that the court should compel the company to permit participation in the supply of gas furnished by it, although it can not furnish enough to satisfy the needs of its existing customers. (State of Indiana ex. rel. Wood *versus* Consumers Gas Trust Co., 55 Lawyers Reports, 245.)

The New York Public Service Commission, second district, in 1915, held that:

> Consideration must be given to a safe and adequate service on the part of the company, within its means and facilities, and if service of this character is being given to a comparatively few customers in a certain locality, with the eliminated amount of gas available for such purpose, it is manifestly the duty of this commission to permit the continuance of such service rather than order the company to turn its gas into a larger field where a safe and adequate service could not be given. (New York Public Service Commission, second district, North Tonawanda case No. 4478, Feb. 25, 1915.)

The Indiana viewpoint is merely a blind following of obsolete precedent. Furthermore, it is based on the erroneous theory that it is a matter of no consequence whether adequate service can be given to any customers, so long as all of the customers stand on an exact equality, and fails to recognize that there is a clear distinction between equity and equality, and that the two are not synonymous.

The New York viewpoint is in accordance with the spirit and letter of up-to-date public utility regulation and recognizes the inherent characteristics and natural limitations of the natural gas industry, and that usable service to a limited number is better than poor or no service to a large number. This New York viewpoint is the just and equitable one to apply to all new service extension problems, as well as to the inevitable problem that will arise in the near future, of limiting or discontinuing the service entirely in certain localities, because the available supply as furnished by nature will not permit the continuance of a usable service to all.

WASTE AND CONSERVATION OF NATURAL GAS.

DEFINITION OF CONSERVATION.[1]

True conservation is not hoarding, but the wise use of natural resources, and it implies not merely the preserving in unimpaired efficiency, but also a wise and equitable exhaustion with a maximum efficiency and a minimum waste. The heart of the natural gas conservation problem is the conflict between the present and the future. The individual land owner is interested primarily only in immediate present personal returns. That is, he is thoughtless and indifferent with respect to the future. The public—at least the 2,000,000 domestic natural gas consumers and the 10,000,000 people dependent on natural gas for their cooking, heating, and lighting purposes—are interested in conserving the supply and bringing about a slow, wise, and economical exhaustion, so as to insure continuity of service for the future.

Conservation, therefore, demands intensive rather than extensive use, takes cognizance of equitable distribution, aims to bring about social justice, and means the greatest good to the greatest number—and that for the longest time.

EXTENT OF WASTE.

Most of the supply and service problems of to-day are the inevitable result of waste in producing and handling natural gas. The annual reports of the conservation committee of the Natural Gas Association of America are stinging indictments of a criminal system, fostered by both the gas companies and the public, that has resulted in wasting more gas than has ever been utilized. The following expert opinions further reflect this appalling situation:

> The history of the natural gas industry of the United States is an appalling record of incredible waste, but it must be told, in order to explain the need for the remedies proposed.[2]

[1] Phraseology suggested by Prof. C. R. Van Hise's The Conservation of Natural Resources in the United States, and Prof. Richard T. Ely's Conservation and Economic Theory. Trans. Amer. Inst. Min. Eng., vol. 54, p. 458.

[2] Technical Paper 38, United States Bureau of Mines, Waste in the Production and Utilization of Natural Gas and Means for their prevention.

In my own State of West Virginia only eight years ago not less than 500,000,000 cubic feet of this precious gas was daily escaping into the air from two counties alone, practically all of which was easily preventable by a moderate expenditure for additional casing.[1]

Of all the pieces of extravagance of which the American people have been guilty, perhaps their reckless and wasteful use of natural gas is the most striking—not the most importar'—but the most striking. This product, severely limited in quantity, which can last only a few years at most, has been handled by us as if it were illimitable.[2]

In reference to natural gas, the great and pressing necessity is to stop its appalling waste by enacting and enforcing proper legislation. This ideal fuel should be used with the severest economy in order to prolong its life, which will be brief at best.[3]

Had the pioneer far-reaching waste eliminating recommendations of Dr. Edward Orton, State geologist of Ohio, and Dr. I. C. White, State geologist of West Virginia, been heeded, most of the acute natural gas service problems of to-day would not exist.

SPECIFIC FORMS OF WASTE.

The various forms of waste may be grouped under drilling, well operation, transmission, and utilization operations.

DRILLING WASTES.

1. *Not closing wells promptly.*—Much gas is wasted on account of delay in closing wells, caused primarily by poor judgment and failure to supply material promptly. In many cases the rock pressure over quite a district has been materially lowered by the delay in closing promptly a single large well in that section.

2. *Improper casing.*—There is much underground waste by improper casing methods which allow gas or water to migrate from their original strata into other strata. This is an especially important feature in the West Virginia fields, where in many instances several gas-bearing formations are superimposed with intervening barren formations.

3. *Waste of gas to air.*—As a result of improper casing methods gas frequently works up around the packer or into the casing above the packer and is wasted in the air.

4. *Gas waste in well-drilling boilers.*—Most gas burning appliances used in well-drilling boilers are crude and inefficient, and the gas is handled as if it had practically no value and were of little use to other people.

5. *Waste of gas in torches.*—A large number of open flame (flambeaux) torches are still in use. Not only is this an inefficient and

[1] I. C. White, State geologist of West Virginia. Address at conference on conservation of natural resources, May 13, 1908.

[2] C. R. Van Hise's The Conservation of Natural Resources in the United States, p. 60.

[3] Idem, 360.

therefore wasteful method of securing illumination at night but in many instances the torches are not shut off during the day.

6. *Offset wells.*—The drilling of offset wells is not only frequently a waste of capital, resulting from overdrilling, but very frequently results in marked waste of gas. This is discussed in further detail on pages 55–57.

7. *Improper plugging.*—Where a well is abandoned and the casing pulled, if the hole is not properly plugged, it may result in the ruination of other gas bearing formations by the migrating of gas or water from one to the other, or the very great waste of gas leaking into coal veins or coming up and passing out into the air.

WELL OPERATION WASTES.

1. *Wasting gas to get oil.*—Where oil and gas are found in the same field it is quite a general practice for oil operators to blow off the gas, that is, waste it, in order to procure the oil. This is the principal cause of the depletion of many gas fields, and is responsible for a greater volume of gas waste than probably all other causes put together.

In tests on over 1,000 oil wells in West Virginia it was shown that the waste of natural gas of each well was at the rate of 12 M cubic feet a day, or 4,380 M cubic feet of natural gas a well per annum. There are at least 16,000 oil wells in West Virginia, and at this rate the annual waste from this source would be at least 70,000,000 M cubic feet of natural gas, equivalent to about one-third of all the natural gas used for domestic consumption in the United States.

2. *Excessive blowing.*—Where wells are blown into the atmosphere for water freeing purposes the gas must, of course, be wasted. However, in many cases the wells are blown longer than necessary, and in others it would be feasible to install siphons for the removal of the water so as to curtail this form of waste.

3. *Salt water troubles.*—In some instances salt water exists in the gas-bearing formation and in others it works in from other strata, due primarily to improper drilling and casing methods. This results in a large waste of gas when the wells must be watered to free them of the salt formation below in the tubing.

4. *Too rapid lowering of the rock pressure.*—The irregular or too rapid lowering of the rock pressure by exceedingly rapid production will always produce undesirable operating conditions, and must ultimately result in a large waste of the total amount of gas that might have been removed with more rational operating methods.

TRANSMISSION WASTES.

1. *Leakage.*—The structural conditions accounting for much of the leakage along gas lines are discussed in detail on page 58. The

leakage in the consumer's house piping beyond the meter is very much larger than ordinarily appreciated. In a number of houses where the leakage has been checked it has been found that in their instances the leakage averaged 19 M cubic feet of gas a year for each house.

2. *Measuring devices curtail leakage.*—The leakage problem is very much greater than ordinarily appreciated, due to the fact that in so many instances measuring appliances are not used for measuring the gas either into the line or out of the line. The more extensive use of measuring devices, if properly installed and the results properly interpreted, would reveal an enormous waste in many lines that are now supposed to be tight.

3. *Blowing drips.*—If the gasoline vapors and water vapor are not removed by drying the gas, considerable gas must be wasted where these vapors, after they have been precipitated in liquid form, must be blown out along the transmission system. The installation of gas drying plants will therefore practically eliminate this form of waste in addition to conserving the gasoline.

UTILIZATION WASTES.

1. *Flat rate.*—Much natural gas is still sold at a flat rate of so much per consumer, or so much for each fire or other fixture. This puts a premium on waste and results in the destruction of an enormous amount of gas that might be conserved for more intelligent and appreciated future use.

2. *Cheap gas for manufacturing.*—When natural gas is sold at low prices for industrial use, there is no incentive to use the gas in an efficient manner, and it is therefore quite frequently used without regard to efficiency or conservation. This is probably the largest form of waste in connection with utilization of natural gas.

3. *Free gas.*—In many cases boom towns in the gas fields have held out the inducement of supplying either free gas or the gas has been sold at ridiculously low prices for industries that would locate there. This feature has been especially troublesome in West Virginia and has resulted in depriving many domestic consumers of an adequate supply of the best fuel available for household use.

In an extensive investigation the amount of gas consumed by domestic consumers in West Virginia having free gas service privileges, on account of having gas wells or gas lines on their farms, it was found that the average consumption per free consumer a year was 480 M cubic feet. This is a waste of at least 350 M cubic feet for each free consumer a year. There are at least 4,400 free consumers in West Virginia, and at this rate of waste this item alone amounts to 1,540,000 M cubic feet a year. This is more than half the amount of gas used in Louisville. The following further emphasizes this form of waste:

Average annual consumption for each free domestic natural gas consumer in West Virginia, 480 M.

Average annual consumption for each domestic natural gas consumer in the United States, 100 M.

Average annual consumption for each domestic consumer at Louisville, 53 M

4. *Carbon black.*—This is a form of improper use rather than absolute waste. The carbon black industry in West Virginia uses 50 per cent more gas than is furnished to all of the domestic natural gas consumers in that State. The economic reasons accounting for the use of natural gas for carbon black manufacture are discussed in detail on pages 60–62.

5. *Inefficient use.*—In many cases natural gas is used without mixers. The data given on page 40 show the marked difference between the use of natural gas in the fire pot of an ordinary coal furnace and a correctly designed natural gas furnace, and the cooking stove and lighting efficiencies emphasize the need of improvements in gas-using appliances.

6. *Thermostat control.*—Thermostats for controlling house-heating appliances are out of the experimental stage, and the large number in use demonstrates their reliability and usefulness. In addition to ministering to the comfort of the house occupants, they aid very materially in conserving the gas consumption by preventing overheating. Where natural gas is sold at low prices the practice is still all too common of lowering the temperature of an overheated room by opening a window rather than by lowering the gas fire.

7. *Discount for low pressure stimulates waste.*—In a number of instances consideration has been given to a penalty clause providing for a discount when pressures lower than 4 ounces are maintained. This has the immediate practical effect of lowering the price of gas during the peak load period and stimulates waste, for the well-known human nature reason that what is made cheap will not be saved. When the consumer believes that his bills will be lower he will attempt to use more gas than he otherwise would, and in this way the cumulative effect will be to still further lower the standard of service to all, in addition to using the gas in a wasteful manner at a time when every thought should be for conservation of the highest order. Whatever may have been the motive for considering the penalty clause, there can be no doubt but that its effect is abortive.

DEFINITION OF "OFFSET WELL."

After a well has been drilled on one farm, the term "offset well," in a narrow sense, means a well drilled on a contiguous farm, directly opposite from the first well and substantially the same distance across from the farm line.

It is not necessary in all cases that the offset well be either directly opposite to or the same distance from the property line as the

well that it is to offset. Thus one well may be an offset to two or more contiguous wells. In other cases the shape of the tract will determine the position of the offset well. The primary feature to be borne in mind is that the offset well is drilled for purposes of protection, and that this is more important than hard and fast rules regarding exact location. The adventitious origin, migratory habits, and fugitive tendencies of natural gas, as well as the nature of the sand and the topography of the country, are also factors that must be considered.

DRILLING OFFSET WELLS MAY MAKE EXISTING WELLS COMMERCIALLY WORTHLESS.

In gas territory the lessee may sink many wells and find gas in them all, but he can utilize only such of them as have a volume and pressure sufficient to enable him to transport the gas through his line and deliver it to the purchaser. If no one of them has the requisite pressure, then no one of them can be utilized; the gas must be wasted, the cost of the wells will be lost, and the lessor entitled to no royalty. What is the proper way to operate a gas lease is therefore a question beset with some difficulty. Its settlement requires some general knowledge of the business and some knowledge of the local field. The lessee may have a good well, from which he can utilize the gas with profit. He may put down another on the same farm and thereby so reduce the pressure in the first as wholly to destroy its value, without getting a sufficient pressure at the second to enable him to utilize that. The gas, if coming from one well, would be of great value. Divided in such manner that the whole volume and pressure at each is below the necessary standard, the whole is lost.[1]

WHY OFFSET WELLS ARE FREQUENTLY DRY.

It is a matter of common observation in natural gas mining that offset well locations are frequently dry holes. This is because most natural gas pools are not strictly continuous, but are made up of many small local pools, frequently surrounded in whole or in part by a gas rock of low porosity. For this reason, if a producing well has been drilled into one of these small local gas pools, there is a large chance that the offset well location may go beyond the limits of the pool and therefore be a dry hole.

WHY OFFSET WELLS ARE FREQUENTLY OF LOW CAPACITY.

The fact that offset natural gas wells are frequently of lower capacity than the wells that they offset may be accounted for as follows:

If the offset well is drilled at the extreme edge of a small local pool its capacity would naturally be smaller than the original well drilled more nearly in the center of the pool. Furthermore, when the first well is drilled into the pool the rush of gas from the then high rock

[1] Pennsylvania Supreme Court. McKnight *versus* Manufacturers Natural Gas Co. (146 Pa. St., p. 185).

pressure has a marked tendency to open up numerous channels of low resistance in the rock formation, so that the gas in the gas sand can get to the well opening with a minimum of friction. The high initial rock pressure aids substantially in first creating such lines of least resistance and then in freeing them of loose particles of sand which are blown out through the well. Even though an offset well is afterwards drilled in the same pool, the initial rock pressure will probably be lower than for the first well, and the lower gas pressure will not be near as likely to produce favorable conditions for flowing to the bottom of the offset well as were produced in the first well.

WHEN IS THE DRILLING OF OFFSET WELLS JUSTIFIABLE?

The crux of the entire "offset well-drilling question" is whether the decision to make the additional investment in drilling offset wells for natural gas, providing the increased annual operating cost for their care and maintenance and cutting down the reserve acreage necessary for future continuity of service, shall be made by the farmer—with no risks involved and no obligation to the public—or the party who must provide the money, assume the financial risk and operating duty to the public. The following correctly expresses the equities of the situation: The development and protection of lines which is implied is such as is usually found in the business of an ordinary prudent man. The operator, who has assumed the obligations, has put his money and labor into the undertaking, and is now called upon to determine whether it will pay to spend some thousands of dollars more in sinking another well to increase the production of the tract, is entitled to follow his own judgment, if that is exercised in good faith, in accordance with the doctrines laid down on page 65.

PUBLIC PAYS FOR WASTEFUL OPERATION.

While the production of natural gas is strictly a mining venture, its distribution to the ultimate consumer is distinctly a public utility service. Even under State regulation of public utilities, any marked increase in the cost of natural gas mining operations will soon be reflected in the price the ultimate consumer must pay for the natural gas service.

The acreage data given in figures 5, 6, and 7 show that not every landowner can have an offset well. The drilling and operation of unnecessary offset wells will represent a large increase in the capital investment and operation cost of natural gas companies. All of such increased burdens represent an unnecessary waste which will ultimately be paid for by the public.

The following analysis gives the reasons for the drilling by one company of 429 wells in West Virginia during 1916, and emphasizes

the offset well burden, as well as the large number that were drilled on the demands of the lessors.

Reason for drilling:	Number of wells.
To save lease	96
Offset	68
For oil	74
For gas	52
Wildcat	4
Requirements of lease	5
Demand of lessors	130
Total	429

GAS LEAKAGE.

The difficulty in keeping gas joints tight is not ordinarily appreciated and results in an enormous waste from defective joints and minute openings in gas-carrying equipment. The laws controlling gas leakage may be stated as follows:

1. The relative leakage tendencies of any two fluids under the same conditions are practically inversely proportional to the square roots of their respective densities. Natural gas has a density of practically 0.64. With regard to air, the relative leakage of air and natural gas will vary as the square root of 1 and square root of 0.8 or as 1 is to 0.8. That is, the leakage tendency of natural gas will be $1 \div 0.8 = 1.25$ times that of air under similar conditions. Water has a density 819.5 times heavier than that of air; hence leakage tendency of natural gas in comparison to that of water at the same pressure is much greater than that of water. This accounts for the universal difficulty in keeping gas confined without leakage.

2. The quantity of leakage through a given opening will vary directly as the square root of the differential pressure.

3. Amount of leakage is independent of the quantity or velocity of gas passing through the main. In other words, the pressure remaining the same, the leakage will be just as much during the period of low gas consumption as during the period of high gas consumption.

A typical gas main joint coupling, as shown on page 59, has four surfaces adjacent to the rubber and the metal where leakage may be possible. On a 16-inch main each coupler presents about 17 linear feet of such potential leakage surface. The magnitude of this in a large system is evident when we consider that about 270 couplers will be required to the mile, thus making $270 \times 17 = 4{,}590$ feet of possible leakage surface to the mile of a 16-inch gas main.

Welded gas mains are coming into use, but the welded process can not be used except on new work or in such main line installations where the entire line can be shut down and drained of all gas before the welding operation is attempted.

DEFINITION OF CARBON BLACK.

In the American trade the term "lamp black" is usually understood to be a soot deposited by the smudge process and made from oil, rosin, or some other solid or liquid raw material, whereas "carbon black" is the term applied to a black deposited by actual contact of a flame upon a metallic surface.[1]

WASTE IN CARBON BLACK MANUFACTURE.

Carbon black is now made by the wasteful process of incomplete combustion of natural gas. That is, the gas is simply burned in the open and the flame impinging against a metal plate makes the black deposit known as carbon black. From 1⅛ to 1½ pounds of carbon

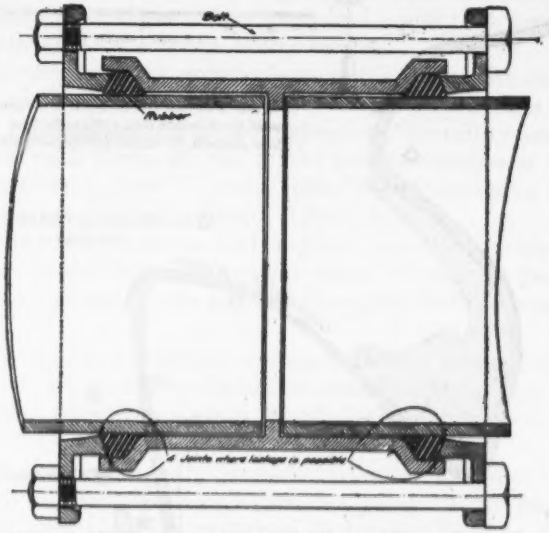

FIG. 19.—LONGITUDINAL SECTION OF GAS PIPE COUPLER SHOWING FOUR POSSIBLE LEAKAGE JOINTS.

black are made to each M cubic feet of gas burned. The only product obtained is the carbon black, and this utilizes only a very small percentage of the total carbon content of the gas.

The total annual quantity of natural gas used for carbon black manufacture is more than 26,000,000 M cubic feet. This wastes about 10 times as much gas as was used in the city of Louisville, or the equivalent of one-eighth of the domestic natural gas consumption in the United States.

Dr. J. B. Garner, of the Mellon Institute of Industrial Research, Pittsburgh, Pa., has demonstrated that with correctly designed appliances the yield of carbon black can be made three times as high

[1] U. S. Geological Survey Statistics. Natural Gas in 1916, p. 662.

as that usually obtained by the wasteful process of incomplete combustion, and in addition thereto save a usable commercial gas.[1]

WHY CARBON BLACK MANUFACTURE MAY BE MORE ATTRACTIVE THAN PUBLIC UTILITY SERVICE.

1. *No regulation.*—Not carrying with it any public duties, it is not subject to the many phases of public regulation that control the marketing of natural gas as a public utility service.

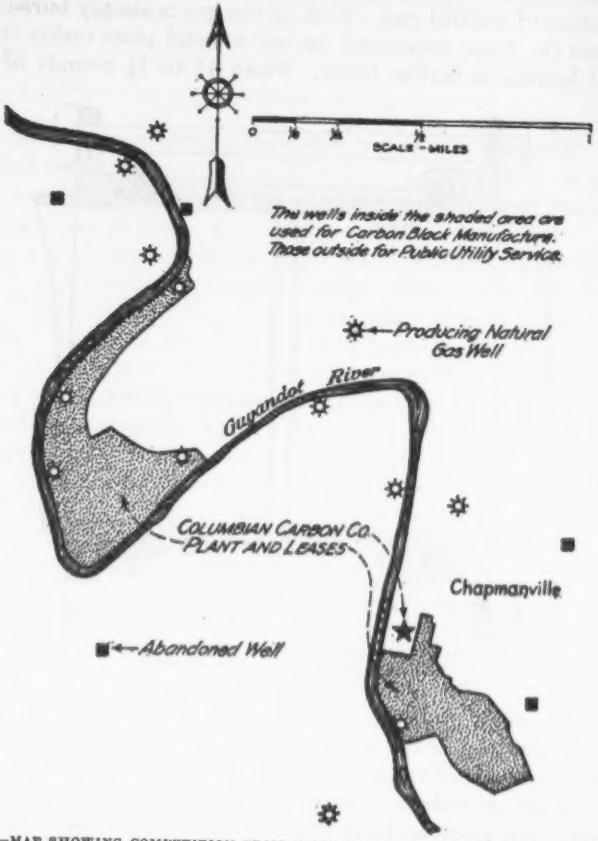
SCALE - MILES
The wells inside the shaded area are used for Carbon Black Manufacture. Those outside for Public Utility Service.
Producing Natural Gas Well
Guyandot River
COLUMBIAN CARBON CO. PLANT AND LEASES
Chapmanville
Abandoned Well

FIG. 20.—MAP SHOWING COMPETITION FROM CARBON PLANT AT CHAPMANVILLE, W. VA.

2. *Price.*—This is not controlled by rate fixing bodies, but is limited solely by the ordinary laws of trade, and is, therefore, more attractive from the investor's viewpoint than governmental price fixing.

3. *No transmission lines necessary.*—The plants are located in the fields, as shown in figure 20, close to the leases, and sometimes on

[1] J. B. Garner The Chemical Possibilities of Natural Gas. Paper, Natural Gas Association of America, Pittsburg meeting, May 23, 1918.

the leases themselves, so that the ordinary gathering lines are the only transmission equipment necessary, and these are so short as to not even require the use of gas compressors. This, of course, makes a marked difference in leakage loss, due to short lines, as well as installation cost.

4. *Uniform load.*—A natural gas plant operating as a public utility, as shown in graphical form on page 37, can use its total equipment only about one-third of the time. That is, it has a load factor of only about 34 per cent. The carbon plant load is uniform every hour in the day and for every day in the year. With the same wells and gathering line equipment it can, therefore, handle approximately three times as much gas as it could if it were selling its gas to the public as a public utility service.

5. The proximity of the carbon plants to the wells, with the resulting short lines, makes it possible to carry lower well pressures than can ordinarily even be reached by contiguous public utility companies having their wells discharge into intake lines to compressor stations. This, in most cases, gives the carbon plant the advantage in pressure over the adjacent competing public utility plant.

6. In a number of instances carbon plants have been located where it would not be feasible, with present prices for natural gas, to lay lines in order to transmit the gas into the public utility transmission systems.

7. The carbon black plants do not carry reserve acreage, as a general rule, and this lowers the capital necessary for the enterprise.

8. The plant hazards are much less than those in a public utility plant.

9. The investment necessary for each 1,000 cubic feet of natural gas handled will be about 10 times larger in a public utility plant than in a carbon black plant, as explained in further detail in the next section.

SMALL CAPITAL IN CARBON BLACK PLANT AS COMPARED TO PUBLIC UTILITY PLANT.

It is not ordinarily appreciated that the investment necessary to render natural gas service is very much greater to each consumer than for any other utility service. That is, the investment to each consumer in natural gas properties, from gas leases to domestic meters, is—

1. Three hundred per cent more than in electric plants, thus requiring $4 investment in natural gas plants to $1 in electric plants for each consumer.

2. One hundred and fifty per cent more than in waterworks plants, thus requiring $2.50 investment in natural gas plants to $1 in waterworks plants for each consumer.

3. One hundred per cent more than all of the Bell Telephone toll lines and Bell exchanges in the United States, thus requiring $2 in-

vestment in natural gas plants to $1 in telephones for each consumer.

4. Fifty per cent more than in ordinary manufacturing gas plants, thus requiring $1.50 investment in natural gas plants to $1 in manufacturing plants for each consumer.

The investment from reserve acreage to domestic consumer's meters in a natural gas plant rendering public utility service and selling on an average of about 100 M cubic feet of natural gas to each domestic consumer a year will be about $220 to each consumer, or $2.20 for each M cubic feet of gas delivered a year.

The investment in a carbon black plant for each M cubic feet of natural gas that may be used a year, taking into account all of the favorable factors enumerated in the preceding section, will be only about 20 cents for each M cubic feet.

This is an unappreciated factor that must be reckoned with in future natural gas service standards.

COMPETITION ALWAYS ECONOMIC WASTE.

Competition in a gas field always results in a duplication of lines, unnecessary wells, enhanced operating cost, lack of proper coordination, failure to remove all the gas, and shortened life of the field, with the inevitable resulting injury to the domestic consumer.

Under competitive conditions, even where the underground gas reservoir is made up of many local pools, various operators will drill into the same local pool, and thus drain out the gas from under each other's leaseholds.[1]

EASE IN DRILLING INVITES COMPETITION.

The easier it is to drill a well in any given territory, the more wells will be drilled by small and inexperienced operators, and the greater will be the inefficient operation of the field. Furthermore, the indiscriminate drilling by inexperienced local operators always tends to increase the use of gas for manufacturing purposes, and takes the gas out at the fastest possible rate, thereby decreasing the effective life of the pool.

CRITICAL NEED OF THE NATURAL GAS INDUSTRY.

The natural gas industry is in a transition stage, going from the large volume and low-priced basis of the past to the small volume and inevitably higher price of the future. Strong individualism dominated the past. Public policy will ultimately require that legalized and regulated collective cooperation rather than cut throat competition, dominate the future. The greatest need of the industry

[1] For further discussion see United States National Museum Bulletin 102, Part 6, on Petroleum: A Resource Interpretation.

to-day is the adequate recognition of the dominating factors in the natural gas conservation problem, which are:

1. Mandatory pooling of field operations, coupled with an adequate market price.

2. Education of the natural gas producers, and of the public, coupled with national constructive legislation. Any legislation, of course, to be of value to the public must be so framed as to stimulate production and the constant search for new supplies.

EFFECT OF GOVERNMENTAL OPPOSITION TO UNIFIED CONTROL.

The present governmental attitude in preventing unity of action in the gas field causes a decrease in the life of the leaseholds, stimulates waste, and increases the cost of the gas to the public. Gas field operating conditions should be regarded as a natural monopoly, so that in the development of the field one company, or one "operating pool," could space the wells properly, and drain the field only at the rate of its safe working capacity, thereby greatly increasing and strengthening the life of the field.

POOLING OF FIELD OPERATIONS MANDATORY IF WASTE IS TO BE REDUCED.

The economic fallacy of competition between untilities is now thoroughly established. Competition, either as a guarantor of good service or regulator of rates, has failed. The doctrine that the public is served best by a legalized and regulated monopoly has become a fixed part of American public utility jurisprudence, and ought to be applied to the mining operations in the natural gas field.

The maximum usefulness could be derived from a pool of oil or gas by its being controlled by one competent management, as under such conditions it could be developed with the least waste and at the smallest cost. However, rarely is a pool under one control; ordinarily a pool is divided among many owners. To get the best results the operators should act in unison for the protection of their common sources of supply and for their mutual benefit. To make cooperation among the producers in a field effective it seems necessary for them to organize with some central authority that can furnish protection against carelessness, inefficient, or even deliberately negligent acts of individuals. The center of this organization should be supplied with all the data affecting the common interests, which could be kept confidential if necessary, and from this information concerning conditions in the field general policies for development and operation could be outlined. That would work to the best interests of all concerned.

There is no business to-day in which, by its very nature, there is more need for cooperation than among the oil and gas operators, yet they have been able to do practically nothing by themselves. Nearly all attempts at cooperation among oil and gas producers have failed, primarily because there was no authority to compel the observance of the will of the majority by individuals who did not choose to follow the policies laid down.[1]

[1] Underground Wastes in Oil and Gas Fields and Methods of Prevention. Technical Paper 130, U. S. Bureau of Mines, pp. 4, 5, by W. F. McMurray and J. O. Lewis.

PROVINCIAL THINKING CAUSE OF MOST NATURAL GAS WASTE.

The provincial habit of looking at natural gas from the dwarfed viewpoint of local use and immediate present is the primary cause of our acute natural gas service problems of to-day. The history of the industry has been one of unrestrained waste and profligate disregard for the public's interest, inevitably increasing demands and obvious physical limitations of supply. This wanton waste has been emphasized by creating and then emphasizing provincial aspects rather than recognizing the true national and interstate nature of the business. The selfish motive of trying to keep the natural resources of a State within the State boundaries, so as to make consumers locate within the State boundaries in order to enable them to use the resource, has been the dominating feature.

The following are three typical economic provincialisms that have been attempted. Although all of these have been unsuccessful, nevertheless they have stimulated the idea that natural gas was so cheap as not to be worth saving, and have therefore been provocative of much waste and misuse:

1. Attempting to prevent exporting gas beyond State limits.
2. Attempting to restrict the pressure which might be maintained in main lines, with the manifest object of preventing sufficient pressure to accomplish satisfactory interstate transmission.
3. Special tax upon the production and transmission of natural gas, and generally this has sought to discriminate in the tax as between gas consumption inside the State as against that transmitted for consumption outside the State.

The urgent present need is a clear appreciation and willing recognition that in the equitable administration of natural resources, like natural gas, there can be no State lines, and that a capital "The" belongs in front of United States in our national name. There is no more sense or justice in any other State either preventing or directly or indirectly burdening the exporting of natural gas, than there would be in applying the same provincial idea to the transportation of food. If it would be just for any State to say that you can not use "our" natural gas unless you locate within our State boundaries, it would be just as fair for the Minnesota farmer to say you can not eat my wheat unless you live within the State boundaries of Minnesota, or for the Louisiana sugar planter to say you can not use my sugar unless you come and live within the State boundaries of Louisiana. The last two viewpoints are so ridiculous that they would not receive serious consideration; yet they represent precisely what has been specifically attempted in the distribution of natural gas.

CHARACTERISTICS OF NATURAL GAS PROSPECTORS AND NEW GAS SUPPLIES.

Natural gas prospectors are optimists, with individualism as the dominating characteristic. They are oversanguine, but if it were not for this characteristic they would not be searching for new supplies of gas. They do things in a big way, take large risks, are good sportsmen, and, therefore, good losers. However, the gains must in the end be more than the losses or they will not continue in the hunt for natural gas supplies for future service.

CONSERVATION OF NATURAL GAS POSSIBLE ONLY WITH PROFITABLE OPERATION.

Natural gas can be found only by diligent prospecting. After it is found the service can be maintained continuously only by further continued development and persistent searching for new supplies. In this development the prospector must figure on many dry holes. The average for all drilling in the entire United States is that every fourth hole is dry. In opening up new fields this may be much higher, brought out elsewhere.

Since the hazards are greater than in any other mining enterprise, the profits ought to be correspondingly greater. This element of profit is the only incentive which impels men to engage in so speculative an enterprise. If, in the aggregate, this amount of profit does not measure up to the hazards in the business the men will cease their work of prospecting and put their capital in safer enterprises. Wherever a close connection exists between effort and profit a stronger resulting incentive is furnished for a further and continuous expenditure of effort. Therefore, a high rate of profit, which will induce men to prospect continuously for natural gas, brings about the condition that more people can use gas and represents a distinct saving to the community.

Natural gas has never been equaled by any man-made product. The worth of natural gas for most high-grade utility services is ahead of any competing commodity or utility service. The only thing that will effectively conserve the supply for future use and thereby insure continuity of future service is an adequate price commensurate with the worth or value of the service. Therefore, the public is served best when natural gas mining is made profitable.

WHEN IS IT COMMERCIALLY FEASIBLE TO CONSERVE GAS OR DEVELOP NEW SUPPLIES?

The feasibility of conserving wastes or developing new supplies and connecting these with a market depends on the coordination of the following factors:

1. A study of the open-flow data in accordance with the doctrines laid down on page 20.

2. Number of dry holes that have been drilled.

3. Probable rock pressure decline.

4. New drilling necessary to maintain production.

5. Total investment necessary in "conservation project" to save the gas.

6. Total investment in leases, wells, compressing stations, and transmission lines necessary to connect the gas with a market.

7. Operating cost of all the preceding factors.

8. In no case would it be prudent business or good judgment to attempt to conserve a waste of gas or develop a new supply that would not take care of the fixed charges on the investment and the operating cost during the life of the gas that is saved or developed on the basis of the volume of gas that can be obtained from such an enterprise and manufactured through the ultimate consumer's meter at the present market prices. An adequate price is therefore the crux of the natural gas conservation question. Unless it is made worth saving by the public it will not be good business judgment to attempt to save it.

PUBLICATIONS OF THE DIVISION OF MINERAL TECHNOLOGY, UNITED STATES NATIONAL MUSEUM.

Publication 2421. Sources of nitrogen compounds in the United States, by Chester G. Gilbert. Issued June 30, 1916, Smithsonian Institution, 12 pp.

Bulletin 102, part 1. Coal products: An object lesson in resource administration, by Chester G. Gilbert. Issued Nov. 17, 1917. 16 pp., 11 pls.

Bulletin 102, part 2. Fertilizers: An interpretation of the situation in the United States, by Joseph E. Pogue. Issued Oct. 10, 1917. 22 pp., 1 pl.

Bulletin 102, part 3. Sulphur: An example of industrial independence, by Joseph E. Pogue. Issued Nov. 7, 1917. 10 pp., 1 fig., 3 pls.

Bulletin 102, part 4. Coal: The resource and its full utilization, by Chester G. Gilbert and Joseph E. Pogue. Issued Feb. 21, 1918. 26 pp.

Bulletin 102, part 5. Power: Its significance and needs, by Chester G. Gilbert and Joseph E. Pogue. Issued Sept. 21, 1918. 50 pp., 2 figs.

Bulletin 102, part 6. Petroleum: A resource interpretation, by Chester G. Gilbert and Joseph E. Pogue. Issued Aug. 1, 1918. 76 pp., 12 figs., 3 pls.

Bulletin 102, part 7. Natural gas: Its production, service, and conservation, by Samuel S. Wyer. Issued ———, 1918.

Bulletin 102, vol. 1. The energy resources of the United States: A plan for reconstruction, by Chester G. Gilbert and Joseph E. Pogue. (In press.)

NOTE.—The papers listed above as parts of Bulletin 102 are members of a series entitled "The mineral industries of the United States."

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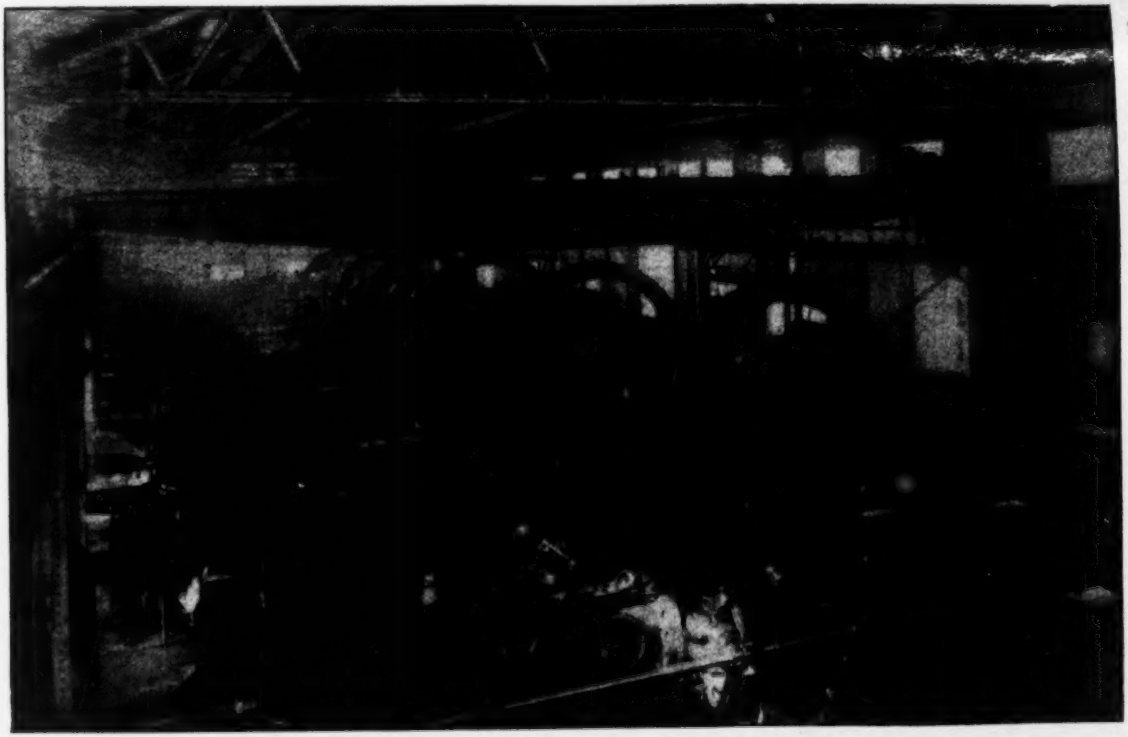


INTERIOR OF NATURAL GAS COMPRESSING STATION.

NATURAL GAS MAIN LINE CONSTRUCTION CONDITIONS.

NATURAL GAS MAIN LINE RIVER CROSSING UNDER CONSTRUCTION.

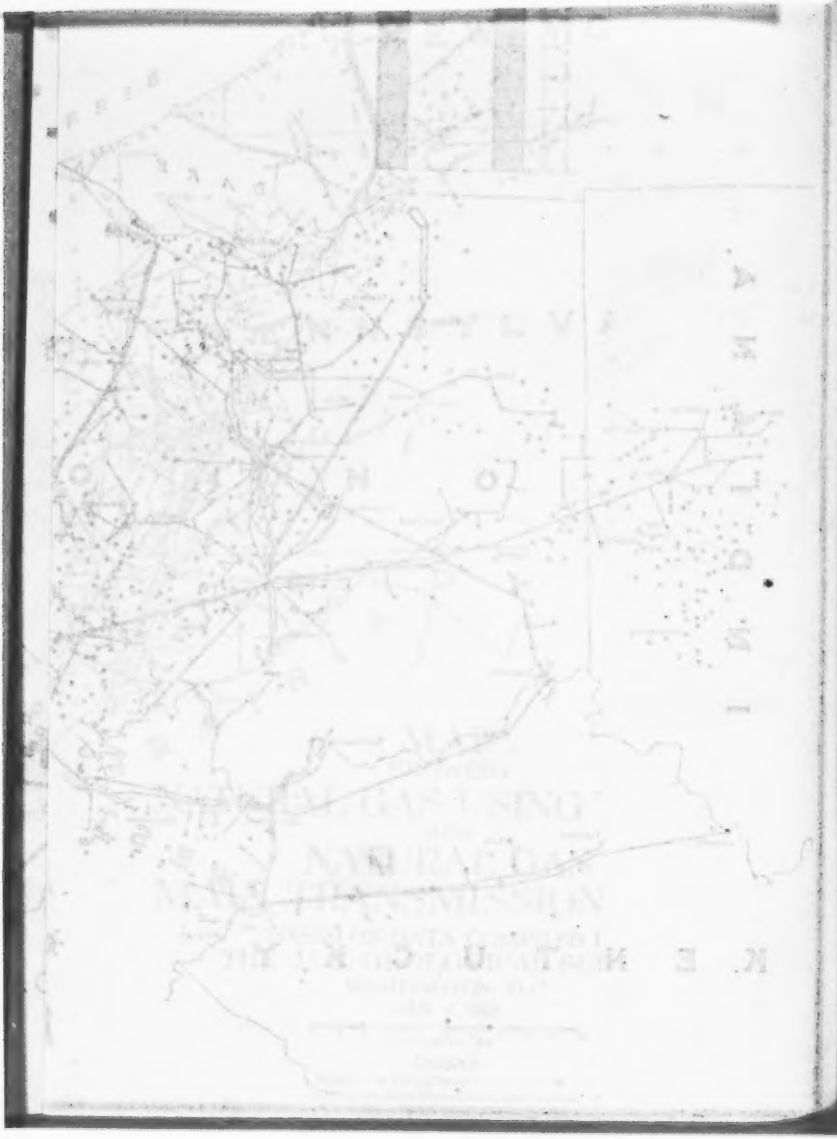
WASTE OF NATURAL GAS IN BLOWING SALT WATER FROM WELL.

U. S. NATIONAL MUSEUM

THE EFFECT OF ELECTROLYSIS ON GAS PIPE.

Gas pipe from Kansas City, Mo., showing holes produced by electrolysis, and therefore many opportunities for waste of gas through leakage. This also produces serious life and property hazard. The term "electrolysis" as here used means the destructive, disintegrating, chemical action, and the resulting damage of underground metallic structures when stray electric currents from electric railways have leaked from their own return circuit and wandered to other underground structures and thence back into the soil.

FOLDOUT(S) IS/ARE TOO LARGE TO BE FILMED



194 OHIO EXHIBIT 1.

Offered at p. 564 of Printed Record by Witness Daly.

Map of Main Lines of the East Ohio Gas Company.

NOTE.—This was replaced by Pennsylvania Exhibit 47.

195 OHIO EXHIBIT 2.

Offered at p. 651 of Printed Record by Witness Denning.

Map of Main Trunk Lines and Transmission Lines of the Ohio Fuel Supply Company.

NOTE.—This was replaced by Pennsylvania Exhibit 49.

195a OHIO EXHIBIT 3.

Offered at p. 681 of Printed Record by Witness Denning.

Administration Order, Public Utility Commission of Ohio, Relative to Discontinuing Gas to Industrial Consumers.

196 OHIO EX. #3.

Office of the Public Utilities Commission of Ohio.

I, J. E. Baird, the duly appointed, qualified and acting Secretary of The Public Utilities Commission of Ohio, in whose custody the books, papers, records, documents and files of said Commission are kept, hereby certify that at a regular session of The Public Utilities Commission of Ohio, held at Columbus, Ohio, upon the fifteenth day of December, 1916, at which Messrs. Beecher W. Waltermire, (Chairman), Lawrence K. Langdon and Louis M. Day, Commissioners, were present, such Commission entered the following order, instituting a proceeding entitled,

"In the matter of the amendment of the schedule of rates for natural gas service of The Union Gas and Electric Company, No. 1024."

"It appearing from statements by the public that an emergency may arise necessitating the temporary alteration or amendment of the schedule of rates for natural gas service of The Union Gas and Electric Company, it is, therefore,

"Ordered, That the Commission proceed, forthwith, to investigate the adequacy of the natural gas service of The Union Gas and Elec-

tric Company with a view to determining the necessity for the temporary alteration or amendment of said company's schedule of rates for natural gas."

which order was, thereupon, served upon said respondent, The Union Gas and Electric Company.

I further certify that, at a regular session of The Public Utilities Commission of Ohio, held at Columbus, Ohio, upon the nineteenth day of December, A. D. 1916, at which Messrs. Beecher W. Waltermire, (Chairman), Lawrence K. Langdon and Louis M. Day, Commissioners, were present, such Commission entered the following orders in the aforesaid proceeding:

"This matter came on to be heard upon the evidence, investigations and reports with reference to the inadequate supply of natural gas by The Union Gas and Electric Company to consumers:

"Upon consideration whereof, the Commission is of opinion and finds that an emergency exists with reference thereto and, in order to preesrve the public health, welfare and interest, that the schedule of rates and regulations of said company on file with the Commission should be temporarily altered and amended to include the following provision, to-wit:

" 'That the service of all consumers of natural gas using one hundred thousand (100,000) cubic feet or more of natural
197 gas per month, may, in the discretion of the Commission, be discontinued without notice.'

It is, therefore,

"Ordered, That the said schedule of The Union Gas and Electric Company on file with the Commission be temporarily altered and amended to include the following provision, to-wit:

'That the service to all consumers of natural gas using one hundred thousand (100,000) cubic feet or more of natural gas per month, may, in the discretion of the Commission, be discontinued without notice.'

It is further

"Ordered, That this order shall be effective on and after this date."

And

"It is

"Ordered, That the service to the following named consumers of the natural gas supply of The Union Gas and Electric Company, said consumers using more than one hundred thousand cubic feet of gas per month, be discontinued forthwith in accordance with the order in proceeding Number 1024:

"North Cincinnati Turnverein,
Crescent Apartments,
Triumph Electric Company,
National Lead Company,
Allis Chalmers Manufacturing Company,
Queen City Forging Company,
Tool Steel Gear and Pinion Company,
Lunkenheimer Company,
Cincinnati Car Company,

Smith and Mills,
American Valve and Meter Company,
William Powell Company,
J. A. Peterson,
Queen City Printing Ink Company,
F. H. Lawson Company,
J. B. Morris,
Ault and Wiborg,
Walnut Hills Laundry,
United States Can Company,
Walnut Street Theatre,
Cincinnati Galvanizing Company,
C. R. Holmes,
Rookwood Pottery Company,
Edwards Manufacturing Company,
Longview Hospital,
Bethany Home,
Cincinnati and Suburban Bell Telephone Company,
College Hill Realty Company, and
The Charles Boldt Company.

It is further

198 "Ordered, That this order be effective on and after this date."

which orders were, thereupon, served upon the respondent, said The Union Gas and Electric Company.

I further certify that, at a regular session of The Public Utilities Commission of Ohio, held at Columbus, Ohio, upon the twenty-first day of December, A. D. 191, at which Messrs. Beecher W. Waltermire, (Chairman), Lawrence K. Langdon and Louis M. Day, Commissioners, were present, such Commission entered the following orders in the aforesaid proceeding:

"It is

"Ordered, That the service to Peter G. Thomson of the natural gas supply of The Union Gas and Electric Company, said consumer using more than one hundred thousand cubic feet of gas per month, be discontinued forthwith in accordance with the order heretofore made in this matter. It is further

"Ordered, That this order be effective on and after this date."

And

"It is

Ordered, That the order, this day made herein, providing for the discontinuance of natural gas service to Peter G. Thomson, be, and it hereby is modified and amended to provide for the discontinuance of service, within one week from the date hereof, to the boiler of said consumer, used for house-heating purposes, consuming more than one hundred thousand cubic feet of gas per month."

which orders were, thereupon, served upon the respondent, said The Union Gas and Electric Company.

I further certify that, at a regular session of The Public Utilities

Commission of Ohio, geld at Columbus, Ohio, upon the thirteenth day of January, A. D. 1917, at which Messrs. Beecher W. Waltermire, (Chairman), Lawrence K. Langdon and Louis M. Day, Commissioners, were present, such Commission entered the following order in the aforesaid proceeding:

"It is hereby

"Ordered, That the service to the consumers of the natural gas supply of The Union Gas and Electric Company using more than One Hundred Thousand (100,000) cubic feet per month, be reduced or discontinued in accordance with the survey and classification, until the further order of the Commission, as shown therein, which survey and classification is adopted and made a part of the record in this proceeding, marked 'Exhibit A.' It is further

"Ordered, That this order be effective on and after this date."

199 which order was, thereupon, served upon the respondent, said The Union Gas and Electric Company.

In testimony whereof, I have hereunto subscribed my name and affixed the official seal of The Public Utilities Commission of Ohio at Columbus, Ohio, this eleventh day of July, A. D. 1921.

[Seal of the Public Utilities Commission of Ohio.]

J. E. BAIRD,
Acting Secretary the Public Utilities Commission of Ohio.

200 OHIO EXHIBIT 4.

Offered at p. 681 of Printed Record by Witness Denning.

Administration Order, Public Utility Commission of Ohio, Relative to Discontinuing Gas to Industrial Consumers.

201 OHIO EX. #4.

Office of the Public Utilities Commission of Ohio.

I, J. E. Baird, the duly appointed, qualified and acting Secretary of The Public Utilities Commission of Ohio, in whose custody the books, papers, records, documents and files of said Commission are kept, hereby certify that at a regular session of The Public Utilities Commission of Ohio, held at Columbus, Ohio, upon the twentieth day of December, A. D. 1916, at which Messrs. Beecher W. Waltermire, (Chairman), Lawrence K. Langdon and Louis M. Day, Commissioners, were present, such Commission entered the following order, instituting a proceeding entitled,

"In the matter of the amendment of the schedule of rates for natural gas service of The East Ohio Gas Company, No. 1025,"

"It appearing from statements by the public that an emergency

may arise necessitating the temporary alteration or amendment of the schedule of rates for natural gas service of The East Ohio Gas Company, it is, therefore,

"Ordered, That the Commission proceed, forthwith, to investigate the adequacy of the natural gas service of The East Ohio Gas Company with a view to determining the necessity for the temporary alteration or amendment of said company's schedule of rates for natural gas."

and, thereupon, upon said day aforesaid, said Commission did enter the following order in said proceeding, viz:

"This matter came on to be heard upon the evidence, investigations and reports with reference to the inadequate supply of natural gas by The East Ohio Gas Company to consumers:

"Upon consideration whereof, the Commission is of opinion and finds that an emergency exists with reference thereto, and, in order to preserve the public health, welfare and interest, that the schedule of rates and regulations of said company on file with the Commission should be temporarily altered and amended to include the following provision, to-wit:

"'That the service to all consumers of natural gas using one hundred thousand (100,000) cubic feet or more of natural gas per month, may, in the discretion of the Commission, be discontinued without notice.'

It is, therefore,

"Ordered, That the said schedule of The East Ohio Gas Company on file with the Commission be temporarily altered and amended to include the following provision, to-wit:

202 "'That the service to all consumers of natural gas using one hundred thousand (100,000) cubic feet or more of natural gas per month, may, in the discretion of the Commission, be discontinued without notice.'

It is further

"Ordered, That this order shall be effective on and after this date."

which orders were, thereupon served upon said respondent, The East Ohio Gas Company.

I further certify that, at a regular session of The Public Utilities Commission of Ohio, held at Columbus, Ohio, upon the sixteenth day of February, A. D. 1917, at which Messrs. Beecher W. Waltermire, (Chairman), Lawrence K. Langdon and Oliver H. Hughes, Commissioners, were present, such Commission entered the following order in said proceeding:

"For good cause the order, made and entered herein on the twentieth day of December, 1916, hereby is vacated and rescinded and this inquiry discontinued."

In testimony whereof, I have hereunto subscribed my name and affixed the official seal of The Public Utilities Commission of Ohio at Columbus, Ohio, this eleventh day of July, A. D. 1921.

[Seal of the Public Utilities Commission of Ohio.]

J. E. BAIRD,
Acting Secretary the Public Utilities Commission of Ohio.

203

OHIO EXHIBIT 5.

Offered at p. 681 of Printed Record by Witness Denning.

Administration Order, Public Utility Commission of Ohio, Relative to Discontinuing Gas to Industrial Consumers.

204

OHIO EX. #5.

Office of the Public Utilities Commission of Ohio.

I, J. E. Baird, the duly appointed, qualified and acting Secretary of The Public Utilities Commission of Ohio, in whose custody the books, papers, records, documents and files of said Commission are kept, hereby certify that at a regular session of The Public Utilities Commission of Ohio, held at Columbus, Ohio, upon the eleventh day of December, A. D. 1917, at which Messrs. Charles C. Marshall, (Chairman), and Beecher W. Waltermire, Commissioners, were present, such Commission entered the following order, instituting a proceeding, entitled,

"In the matter of the investigation by the Commission to determine the existence of an emergency necessitating the alteration or amendment of the schedules of The Union Gas and Electric Company for natural gas service, No. 1350,"

"It being made to appear to the Commission that an emergency may exist necessitating the temporary alteration or amendment of the schedules of rates for natural gas service of The Union Gas and Electric Company, it is, therefore,

"Ordered, That the Commission proceed, forthwith, to investigate the adequacy of the natural gas service of The Union Gas and Electric Company with a view to determining the necessity for the temporary alteration or amendment of said company's schedules of rates for natural gas service."

which order, was, thereupon served upon said respondent, The Union Gas and Electric Company, and

I further certify that, at a regular session of The Public Utilities Commission of Ohio, held at Columbus, Ohio, upon the twelfth day of December, A. D. 1917, at which Messrs. Charles C. Marshall, (Chairman), and Beecher W. Waltermire, Commissioners, were present, such Commission entered the following order in the aforesaid proceeding:

"This matter came on to be heard upon the evidence, investigations and reports with reference to the inadequate Supply of natural gas by The Union Gas and Electric Company to consumers:

"Upon consideration whereof, the Commission is of the opinion and finds that an emergency exists with reference thereto, and that, in order to preserve the public health, welfare and interest, the schedule of rates and regulations of said company on file with the Commission should temporarily be altered and amended to include the provisions of the following order. It is, therefore,

"Ordered, That the schedule of The Union Gas and Elec-
205 tric Company for natural gas service, on file with this Commission, temporarily be altered and amended to include the following provisions, to-wit:

" 'That the service of natural gas to each and every consumer, other than for use in private residences and in hospitals and similar charitable institutions, may, in the discretion of the Commission be immediately discontinued without notice, subject, however, to temporary stay of operation of the order of discontinuance in the specific instances or classes of consumers designated and reported to the Commission by a representative thereof, upon investigation made through such representative.'

It is further

"Ordered, That this order shall be effective on and after this date, and for so long as said emergency shall exist, or until the further order of the Commission. It is further

"Ordered, That The Union Gas and Electric Company immediately discontinue and cause to be disconnected so long as necessary to furnish an adequate supply of gas to domestic consumers, the service of natural gas to all consumers comprised in the following classifications, to wit:

"Classification 1: All industrial consumers using natural gas in boiler furnaces or in manufacturing or industrial process.

"Classification 2: All consumers using natural gas for heating or power purposes in buildings and offices and establishments other than private residences.

"Classification 3: All consumers using natural gas for the operation of gas engines.

"Classification 4: All consumers operating restaurants, hotels, clubs and dining rooms using natural gas in the preparation of food.

"Provided: That temporary stay of the immediate operation of this order is hereby granted to such specific consumers, for good cause shown and where necessary to preserve the health, interest and welfare of the public, as shall be designated by the Commission."

which order was, thereupon, served upon the respondent, said The Union Gas and Electric Company.

In testimony whereof, I have hereunto subscribed my name and affixed the official seal of The Public Utilities Commission of Ohio at Columbus, Ohio, this eleventh day of July, A. D. 1921.

[Seal of the Public Utilities Commission of Ohio.]

J. E. BAIRD,
Acting Secretary the Public Utilities Commission of Ohio.

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OHIO EXHIBIT 6.

Offered at p. 681 of Printed Record by Witness Denning.

Administration Order, Public Utility Commission of Ohio, Relative to Discontinuing Gas to Industrial Consumers.

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OHIO EX. #6.

Office of the Public Utilities Commission of Ohio.

I, J. E. Baird, the duly appointed, qualified and acting Secretary of The Public Utilities Commission of Ohio, in whose custody the books, papers, records, documents and files of said Commission are kept, hereby certify that at a regular session of The Public Utilities Commission of Ohio, held at Columbus, Ohio, upon the nineteenth day of December, A. D. 1916, at which Messrs. Beecher W. Waltermire (Chairman), Lawrence K. Langdon and Louis M. Day, Commissioners, were present, such Commission adopted the following order, which was thereupon served upon each and every Natural Gas Company furnishing service to consumers within the State of Ohio:

"Administrative Order No. 28.

"The Commission having under consideration the furnishing of natural gas to consumers within Ohio and having, through its experts and examiners, made a careful investigation of the situation, taken the pressure in various parts of the State, examined conditions and ascertained that there is a stortage of gas in many localities of the State, creating an emergency therein, finds that there is an insufficient supply of natural gas to furnish both domestic and industrial consumers.

"The Commission further finds that the schedules of the various companies, so furnishing said gas, on file with the Commission show that industrial consumers, or the 'non-preferred class,' are, for the most part, furnished service under what is known as a 'uniform contract,' which contract provides that their service is subject to discontinuance and disconnection at any time and under any circumstances upon summary notice by the gas company, subject to the conditions of the 'uniform contract,' or clauses of like import. It is, therefore,

"Ordered, That each and every company furnishing natural gas to both domestic and industrial consumers within the State of Ohio proceed, forthwith, to a strict enforcement of the terms of said 'uniform contract' and to enforce the conditions of said schedules by the discontinuance of said 'non-preferred' or industrial class in each and every locality where the supply of gas is not adequate and sufficient to furnish a reasonable supply to both; and to continue such disconnection until such time as adequate service can be furnished to both. It is further

"Ordered, That each and every public utility furnishing natural gas as aforesaid in any locality when, after the disconnection of industrial consumers, the supply is not adequate to supply domestic consumers, forthwith make report of such facts, together
208 with a list of any and all other consumers not within the domestic class but not subject to summary discontinuance, for further order of the Commission."

In testimony whereof, I have hereunto subscribed my name and affixed the official seal of The Public Utilities Commission of Ohio at Columbus, Ohio, this eleventh day of July, A. D. 1921.

[Seal of the Public Utilities Commission of Ohio.]

J. E. BAIRD,
Acting Secretary the Public Utilities Commission of Ohio.

209 EXHIBIT 7.

Offered at p. 681 of Printed Record by Witness Denning.

Administration Order, Public Utility Commission of Ohio, Relative to Discontinuing Gas to Industrial Consumers.

210 OHIO EX. 7.

Office of the Public Utilities Commission of Ohio.

I, J. E. Baird, the duly appointed, qualified and acting Secretary of The Public Utilities Commission of Ohio, in whose custody the books, papers, records, documents and files of said Commission are kept, hereby certify that at a regular session of The Public Utilities Commission of Ohio, held at Columbus, Ohio, upon the twenty-first day of May, 1918, at which Messrs. Charles C. Marshall (Chairman), Beecher W. Waltermire and Byron M. Clen Dening, Commissioners, were present, such Commission adopted the following order, which was thereupon served upon each and every Natural Gas Company furnishing service to consumers within the State of Ohio:

"Administrative Order No. 34.

The Public Utilities Commission, having under consideration the probable inability of natural gas companies to furnish an adequate

supply to all their consumers during the coming Winter, and the necessity of formulating more definite rules for the guidance of such public utility companies in disconnecting industrial and other consumers from the service, when necessary, during an emergency, to conserve the supply for domestic consumers, and the order in which disconnection should be made, as well as the order in which the service should be restored when the emergency is passed, hereby adopts the following rules and regulations, to wit:

1. That for the purpose of disconnecting or curtailing service to consumers during an emergency, all consumers of natural gas are divided into two general classes, namely: Domestic Consumers and Industrial Consumers.

2. That domestic consumers, for such purposes, include the users of natural gas for heating, lighting and cooking in private homes, boarding houses, and apartment houses; and users of natural gas for lighting and cooking only, in hotels, restaurants, bakeries, eating places, club houses, hospitals and other charitable institutions.

3. That all other consumers shall be designated as "Industrial Consumers"; but for the purpose of disconnecting or curtailment during an emergency, the following subdivisions of industrial
211 consumers may be made, in cases where there is more than a sufficient supply of gas for domestic consumers as herein specified, but not a sufficient supply for all industrial consumers:

A. Users who are not included in the domestic consumers' class, as herein specified, but who are engaged in preparing or preserving foodstuff, or food producing plants, for such purposes only.

B. Industries directly engaged in manufacturing or producing war materials, for such purposes only; and users of gas in gas engines.

C. All other industrial consumers.

When there is not sufficient gas for all industrial consumers, as herein defined, the surplus shall be furnished to industrials in the order above named.

4. This classification is subject to the following exception: Where natural gas is being used in limited quantities for scientific, experimental, or mechanical purposes, and where other means of producing light and heat for such purposes cannot be reasonably substituted, an amount essential to such use, but not to exceed five thousand (5,000) cubic feet per month to each consumer so engaged may be used for such purposes only, and as if they were included in the class of domestic consumers herein specified.

5. If, after disconnecting all industrial consumers, there is not a sufficient supply of gas for the domestic consumers, then all boilers and furnaces not provided with gas fixtures and appliances primarily designed for burning natural gas as a fuel shall be disconnected; and if it becomes necessary to further restrict the use of gas to meet

the emergency, domestic consumers may be limited to the use of thirty-five thousand (35,000) cubic feet per month, in one building, or for one family.

6. A copy of these regulations shall be furnished by each natural gas company to its consumers not later than June 15, 1918.

7. Consumers who do not promptly disconnect or curtail, in accordance with these rules and regulations, when notified by the utility that it is necessary so to do, shall, upon discovery, be wholly disconnected from the service until the emergency is passed."

212 In testimony whereof, I have hereunto subscribed my name and affixed the official seal of The Public Utilities Commission of Ohio at Columbus, Ohio, this eleventh day of July, A. D. 1921.

[Seal of the Public Utilities Commission of Ohio.]

J. E. BAIRD,
Acting Secretary the Public Utilities Commission of Ohio.

213 OHIO EXHIBIT 8.

Offered at p. 681 of Printed Record by Witness Denning.

Administration Order, Public Utility Commission of Ohio, Relative to Discontinuing Gas to Industrial Consumers.

214 OHIO EX. #8.

Office of the Public Utilities Commission of Ohio.

I, J. E. Baird, the duly appointed, qualified and acting Secretary of The Public Utilities Commission of Ohio, in whose custody the books, papers, records, documents and files of said Commission are kept, hereby certify that at a regular session of The Public Utilities Commission of Ohio, held at Columbus, Ohio, upon the tenth day of June, 1919, at which Messrs. Charles C. Marshall (Chairman), Beecher W. Waltermire and Byron M. Clen Dening, Commissioners, were present, such Commission dopted the following order, which was thereupon served upon each and every Natural Gas Company furnishing service to consumers within the State of Ohio:

Administrative Order No. 41.

"The Commission again having under consideration the probable inability of the natural gas companies to furnish an adequate supply to all consumers during the coming winter season:

It is

Ordered, That Administrative Order No. 34, promulgated by this Commission under date of May 21, 1918, be, and hereby it is re-

newed and continued in full force and effect for the further period of one year, with the modification that instead of being required to furnish its consumers with a copy of said order, each natural gas company operating in the State of Ohio shall give notice to each consumer of the extension of said order not later than July 15, 1919."

In testimony whereof, I have hereunto subscribed my name and affixed the official seal of The Public Utilities Commission of Ohio at Columbus, Ohio, this eleventh day of July, A. D. 1921.

[Seal of the Public Utilities Commission of Ohio.]

J. E. BAIRD,
Acting Secretary the Public Utilities Commission of Ohio.

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OHIO EXHIBIT 9.

Office of the Public Utilities Commission of Ohio.

Administrative Order, Public Utility Commission of Ohio, Relative to Discontinuing Gas to Industrial Consumers.

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OHIO EX. #9.

Office of the Public Utilities Commission of Ohio.

I, J. E. Baird, the duly appointed, qualified and acting Secretary of The Public Utilities Commission of Ohio, in whose custody the books, papers, records, documents and files of said Commission are kept, hereby certify that at a regular session of The Public Utilities Commission of Ohio, held at Columbus, Ohio, upon the 12th day of August, 1920, at which Messrs. Charles C. Marshall (Chairman), Beecher W. Waltermire and Byron M. Clen Dening, Commissioners, were present, such Commission adopted the following order, which was thereupon served upon each and every Natural Gas Company furnishing service to consumers within the State of Ohio:

"Administrative Order No. 46.

The Public Utilities Commission, having under consideration the inability of natural gas companies to furnish an adequate supply to all their consumers during severe weather, and the necessity of formulating more definite rules for the guidance of such public utility companies in disconnecting industrial and other consumers from the service, when necessary, during an emergency, to conserve the supply for domestic consumers, and the order in which disconnections should be made, as well as the order in which the service should be restored when the emergency is passed, hereby adopts the following rules and regulations, to-wit:

1. That for the purpose of disconnecting or curtailing service to consumers during an emergency, all consumers of natural gas are

divided into two general classes, namely: Domestic Consumers and Industrial Consumers.

2. That domestic consumers, for such purposes, include the users of natural gas for heating, lighting and cooking in private homes, boarding houses, and apartment houses; the users of natural gas for lighting and cooking only, in hotels, restaurants, bakeries, eating places, club houses, hospitals and other charitable institutions, and in places of like kind where the element of human welfare is the predominating requirement.

3. That all other consumers shall be designated as "Industrial Consumers"; but for the purposes of disconnecting or curtailment during an emergency, the following subdivisions of industrial consumers may be made, in cases where there is more than a sufficient supply of gas for domestic consumers as herein specified, but not a sufficient supply for all industrial consumers:

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A. Users who are not included in the domestic consumers' class, as herein specified, but who are engaged in preparing or preserving foodstuff, or food producing plants, for such purposes only.

B. Users of gas in gas engines.
(1. Those using 150,000 cu. ft. or less per month.
(2. Those using more than 150,000 cu. ft. per month.

C. All other industrial consumers.

When there is not sufficient gas for all industrial consumers, as herein defined, the surplus shall be furnished to industrials in the order above named.

4. This classification is subject to the following exceptions: Where natural gas is being used in limited quantities for scientific, experimental, or mechanical purposes, and where other means of producing light and heat for such purposes cannot be reasonably substituted, an amount essential to such use, but not to exceed ten thousand (10,000) cubic feet per month to each consumer so engaged may be used for such purposes only, and as if they were included in the class of domestic consumers herein specified.

5. If, after disconnecting all industrial consumers, there is not a sufficient supply of gas for the domestic consumers, then all boilers and furnaces not provided with gas fixtures and appliances primarily designed for burning natural gas as a fuel shall be disconnected, and if it becomes necessary to further restrict the use of gas to meet the emergency, domestic consumers may be limited to the use of thirty-five thousand (35,000) cubic feet per month, in one home, or for one family.

6. Realizing the necessity of conserving natural gas, and that, to do so, it should be used in the most economical manner, the Commission recommends that all distributing companies make a special study of the best methods of using the same,

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and of the most economical appliances which have been designed for such use, and that they notify their consumers of their willingness to make free inspection of premises and give free advice as to such changes, if any, in their present fixtures and appliances as will accomplish that purpose, together with an estimate of the cost of the same; but no such company shall have authority to require any such changes to be made. Any gross wasteful use of gas by a consumer should be reported to the Commission.

7. A copy of these regulations shall be furnished by each natural gas company to its consumers not later than September 1, 1920.

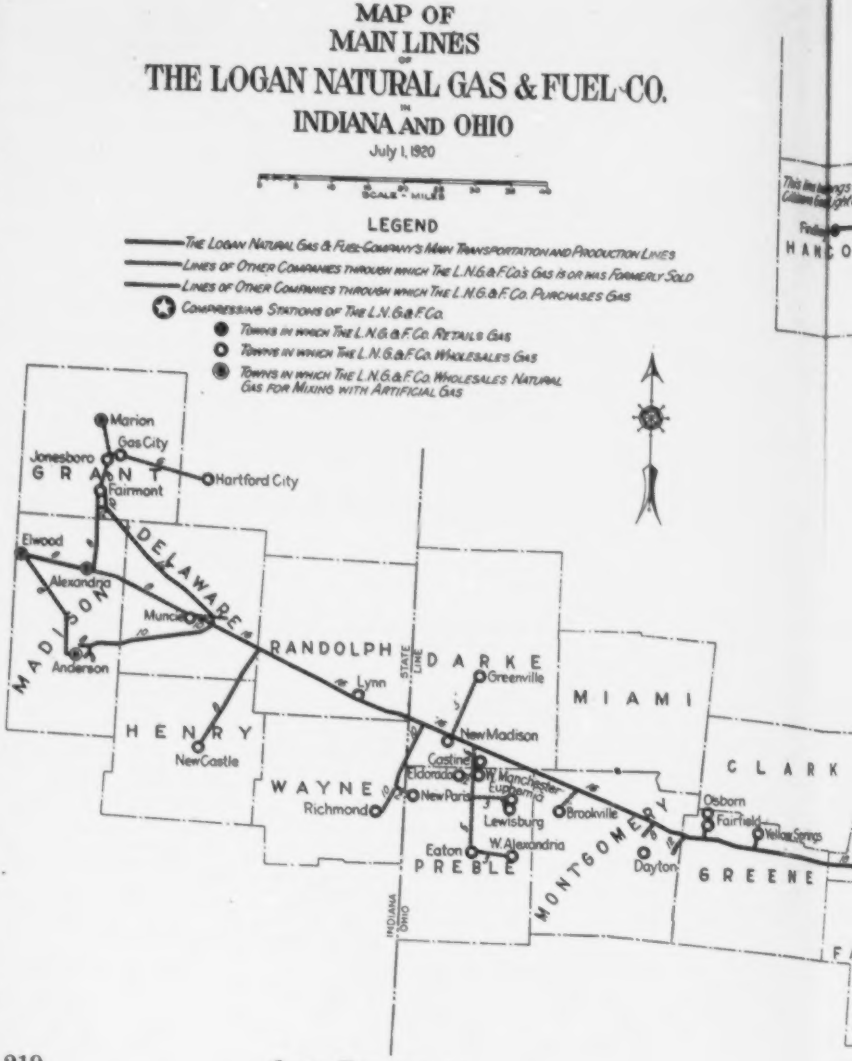
8. Consumers who do not promptly disconnect or curtail, in accordance with the rules and regulations, when notified by the utility that it is necessary so to do, shall, upon discovery, be wholly disconnected from the service until the emergency is passed.

In testimony whereof, I have hereunto subscribed my name and affixed the official seal of The Public Utilities Commission of Ohio at Columbus, Ohio, this eleventh day of July, A. D. 1921.

[Seal of The Public Utilities Commission of Ohio.]

J. E. BAIRD,
Acting Secretary the Public Utilities Commission of Ohio.

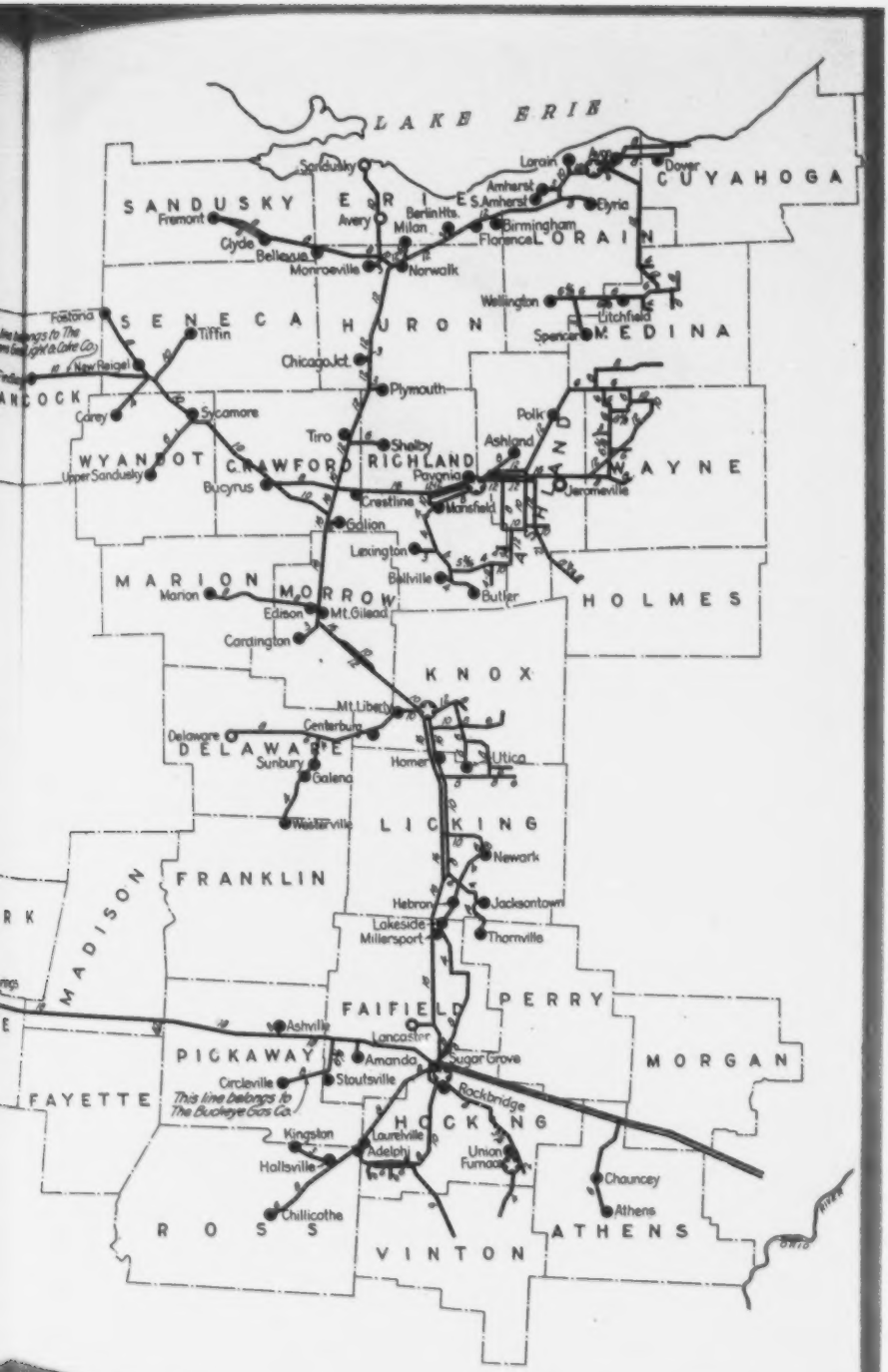
(Here follows map of main lines of Logan Natural Gas & Fuel Company in Indiana and Ohio, marked page 219.)



OHIO EXHIBIT 10.

Offered at p. 750 of Printed Record by Witness Whitcomb.

Map of Main Lines of Logan Natural Gas & Fuel Company in Indiana and Ohio.


LAKE ERIE
Sandusky
Lorain
Avon
Dover
SANDUSKY
ERIE
Amherst
S.Amherst
Elyria
CUYAHOGA
Fremont
Avery
Berlin Hts.
Milan
Birmingham
Florence
LORAIN
Clyde
Bellevue
Monroeville
Norwalk
Wellington
Litchfield
Spencer
MEDINA
Fostoria
SENECA
HURON
Tiffin
New Reigel
Chicago Jct.
Plymouth
Carey
Sycamore
Tiro
Shelby
Polk
Ashland
WYANDOT
CRAWFORD
RICHLAND
WAYNE
Upper Sandusky
Bucyrus
Paygnia
Crestline
Mansfield
Jeromeville
Galion
Lexington
Ballville
Butler
MARION
MORROW
HOLMES
Marion
Edison
Mt.Gilead
Cardington
KNOX
Mt.Liberty
Centerburg
Delaware
DELAWARE
Sunbury
Galena
Homer
Utica
Westerville
LICKING
Newark
FRANKLIN
MADISON
Hebron
Jacksontown
Lakeside
Millersport
Thornville
FAIRFIELD
PERRY
Ashville
Lancaster
PICKAWAY
Amanda
Sugar Grove
MORGAN
Circleville
Stoutsville
Rockbridge
FAYETTE
This line belongs to The Buckeye Gas Co.
HOCKING
Kingston
Laurelville
Adelphi
Union Furnace
Chauncey
Hallsville
Chillicothe
ROSS
VINTON
ATHENS
Athens
OHIO RIVER